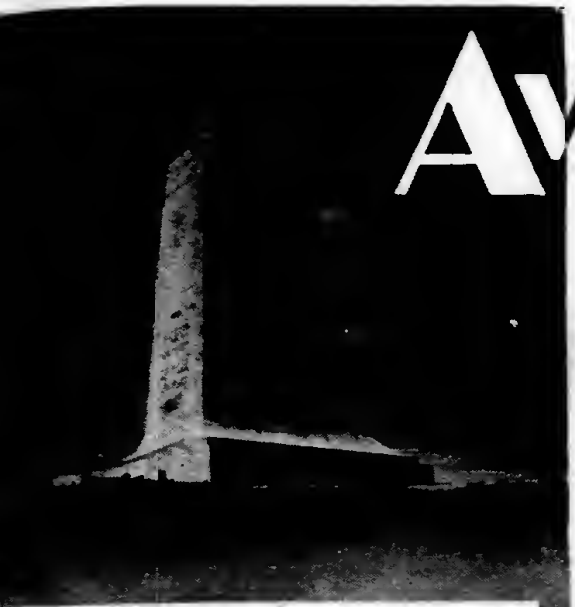

AVIATION

CONTENTS FOR MARCH, 1945

Volume 44 • Number 3

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Now that the 64 ATS schools have practically completed their pilot-training job—and a magnificent one it's been—what to do with their facilities? Will their fields, hangars, barracks, and other equipment lie idle? There's no reason why they should, says Southwest Airways' President John Connelly, who discusses several alternative plans. In what he says, there's plenty of food for thought, not only for fixed base operators, but also for government officials and just plain tax-paying citizens. Turn to "Let's *Keep Using* Those Contract Schools" (page 109).

Distributors and manufacturers alike will be vitally interested in the concluding part of our series on foreign trade, for this month our Financial Editor wraps this important package up with practical one-two-three suggestions on just "How to Get Your Share of Export Sales." (Page 116).

In the old days, armies traveled on their stomachs—sometimes literally as well as figuratively. But nowadays they travel more and more on wings; and in the future they may well move that way almost exclusively. Just how the Army Air Forces has developed this art to its highest degree, and what the future holds for vertical envelopment, is dramatically told by Brig. Gen. William D. Old (above) Commanding General of our First Troop Carrier Command, in "They'll Put Wings on Armies," page 106. (AAF photo).

Dealers, distributors and potential personal plane owners this month have three new craft to add to their lists of possible planes to sell or buy, for on pages 172 and 173 we present all the now-available data on three new craft —a $900-$1,000 one-place, and a $3,998 four-place job by Piper; also a two-control craft by Aeronca.

For those who already have personal planes they want to keep in top condition, we continue our series of Lubrication Charts, this month covering the Fairchild 24 and Stinson's 105 and Reliant.

Anyone —be he a fixed base or airline operator—wants to keep his airplanes out of the hangar where they'll make money, which means improved maintenance methods. Howard Ingalls, Northeast Airlines' v-p. of maintenance and engineering, presents a system (page 159) for "perpetual overhaul" that's as applicable to the individual operator as it is to the airline . . . Also in the maintenance field is the second of "Al" Lindsley's "handbook" series, which includes a lucid trouble shooting chart that should prove valuable in the small fixed base operation as it is in the largest airline shop (page 164).

And now a pause from page numbers to tell Col. Carl Norcross' legion of friends he's been awarded the Legion of Merit, a well-earned citation for his outstanding work in setting up many of the basic intelligence methods now used by the entire 8th Air Force. You'll recall our former Managing Editor went overseas with Lt. Gen. Ira Eaker's original staff—the first U. S military perty to reach England after Pearl Harbor. Carl now is chief intelligence officer of the Third Bombardment Division, which was cited by President Roosevelt for setting up the England-Africa shuttle run, which proved so effective in bombing Messerschmitt plants, and later the England-Russia shuttle run.

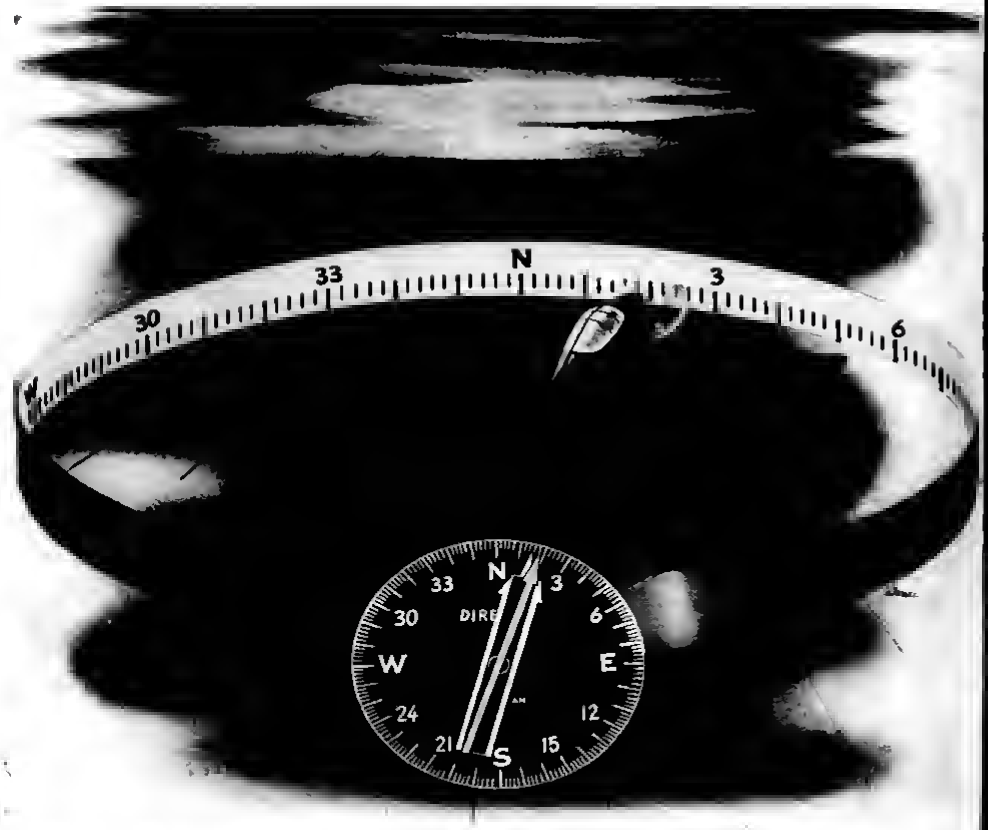
Establishing "firsts" has been quite a habit with North American Aviation's famed B-25 Mitchell bomber, including that never-to-be-forgotten first over Tokyo. C. J. Hansen (above), NAA's Chief Project Engineer, has lived with the B-25 since its pre-prototype days, and thus is in the best possible position to analyze the two latest models—the 75-mm. cannon-packing "H" and the gun-bristling medium bomber, "J." This great two-in-one analysis job begins on page 119.

Down the Years in AVIATION'S Log

25 Yr. Ago (1920)—First torpedo plane delivered to Navy by Glenn L. Martin. . . . Twelve Fokker pursuit planes delivered here by Germany. . . . Army builds first portable engine cranker. . . . San Francisco opens first aero show. . . . Post Office reports that icing is chief cause of winter forced landings. . . . Major "Shorty" Schroeder flies supercharged Liberty-engine Lepere biplane to 35,000 ft.

15 Yr. Ago (1930)—Total of 160,000 visit St. Louis aero show in week. . . . Lee Schoenhair breaks six weight-speed records with Lockheed Vega. . . . Time-payments for planes inaugurated by finance company. . . . Mid-South Aeronautic Assn. holds first conference . . . Hawley Bowlus soars 9 hr. 5 min. to set new U. S. record.

10 Yr. Ago (1935)—Pan American starts bases at Wake, Guam, and Midway . . . Army requests $11,000,000 for Hawaiian airbase and $79,000,000 for equipment, including 800 new planes. . . Aero Chamber meets at Brownsville, Tex . . . D of C awards contract to Waterman for tailless plane. . . . Los Angeles Union Air Terminal handled 38,976 revenue passengers in year. . . Railway Express Agency reports tonnage up 115 percent and revenue up 90 percent for year in spite of reduced rates. . . . Post Office disputes ICC's authority to regulate airmail rates. . . . Washington-South America-and-return air race postponed . . . Codos and Rossi fail in trans-Atlantic hop because of oil feed leak. . . . Autogiro takes off from and lands on, deck of cruiser.



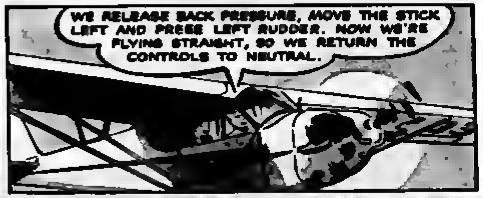
FLIGHT-LIKE INDICATION is the characteristic of the Kollsman Direction Indicator which makes it so well liked by many pilots. All of the points in azimuth are visible at all times, reading clockwise as on the compass rose of a navigation chart. A distinctive memo pointer may be set to the desired course so that any deviation is immediately apparent. The pilot merely keeps the pointers matched. These features make the instrument easy to read, easy to follow. Excellent performance characteristics also aid the flyer. The Direction Indicator is self-contained and fits the standard compass mounting, requiring only a light connection.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK · GLENDALE, CALIFORNIA



Get Your "How to Fly" Booklet NOW!

New booklet, "How to Fly a Piper Cub", covers the fundamentals of flying with over 50 step-by-step photos and descriptions. Many other facts, full-color pictures of Piper Cubs. Send 10c in stamps or coin for postage-handling. Write Piper Aircraft Corp., Dept. A35, Lock Haven, Penna.

IS YOUR TOWN READY TO FLY?

It should plan landing facilities now—for its citizens and its future. The booklet, "What Your Town Needs for the Coming Air Age," illustrates various types. It covers benefits, where to build and how to start. For your free copy write Piper Aircraft Corp., Dept. A35W, Lock Haven, Penna.

16 mm. SOUND FILM—"The Construction of a Light Airplane." For distribution points write Supervisor, Audio-Visual Aids, Extension Services, Pennsylvania State College, State College, Penna.

PIPER "PLANE QUIZ"

1. What would it cost, in gas and oil, to fly from Chicago to New York in a Piper Cub? **Less than ten dollars.**
2. How long does it take to learn to fly a Piper Cub? **6 hours instruction required before soloing.**
3. What is the longest a Piper Cub engine ever ran continuously in flight? **726 hours continuously.**
4. Will it be easy to buy a peacetime Cub? **Yes, with a moderate down payment and easy terms.**

This lesson and others that will follow explain only the fundamentals. See your Piper Cub dealer for actual flying instruction. Write us "Plane Quiz" questions you want answered.

PIPER AIRCRAFT CORPORATION—LOCK HAVEN, PENNA.
In Canada — Cub Aircraft, Ltd., Hamilton

PIPER CUB

Points the Way to Wings for ALL Americans

GOODYEAR AIRCRAFT PRODUCTION REPORT

CONTRACTS: NOAS1871-99529-NOAS951

CORSAIR FG-1

COMPLETE AIRPLANE
AND SPARE COMPONENT PARTS

CONTRACT RECEIVED	FEBRUARY 1942
FIRST PRODUCTION UNIT COMPLETED	FEBRUARY 1943
1000TH PRODUCTION UNIT DELIVERED	MARCH 1944
2500TH PRODUCTION UNIT DELIVERED	JANUARY 1945

REMARKS: At the time the contract was undertaken, Goodyear Aircraft Corporation did not have a plant large enough for this giant job. Yet within one year a modern conveyor-line assembly plant was erected and tooled, 10,000 employees trained in quantity production techniques, and the first unit completed. In the second year, output was increased to several hundred finished aircraft and spare components per month. During this period, the plane was modified to reflect combat experience involving many improvements which were incorporated. Yet the flow of aircraft was maintained in accordance with Navy expectations.

Goodyear builds components for 16 different types of Army Navy aircraft, including complete airships as well as the Corsair

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRCRAFT INDUSTRY

1. By constructing major components to manufacturers' specifications

2. By designing parts for all types of airplanes

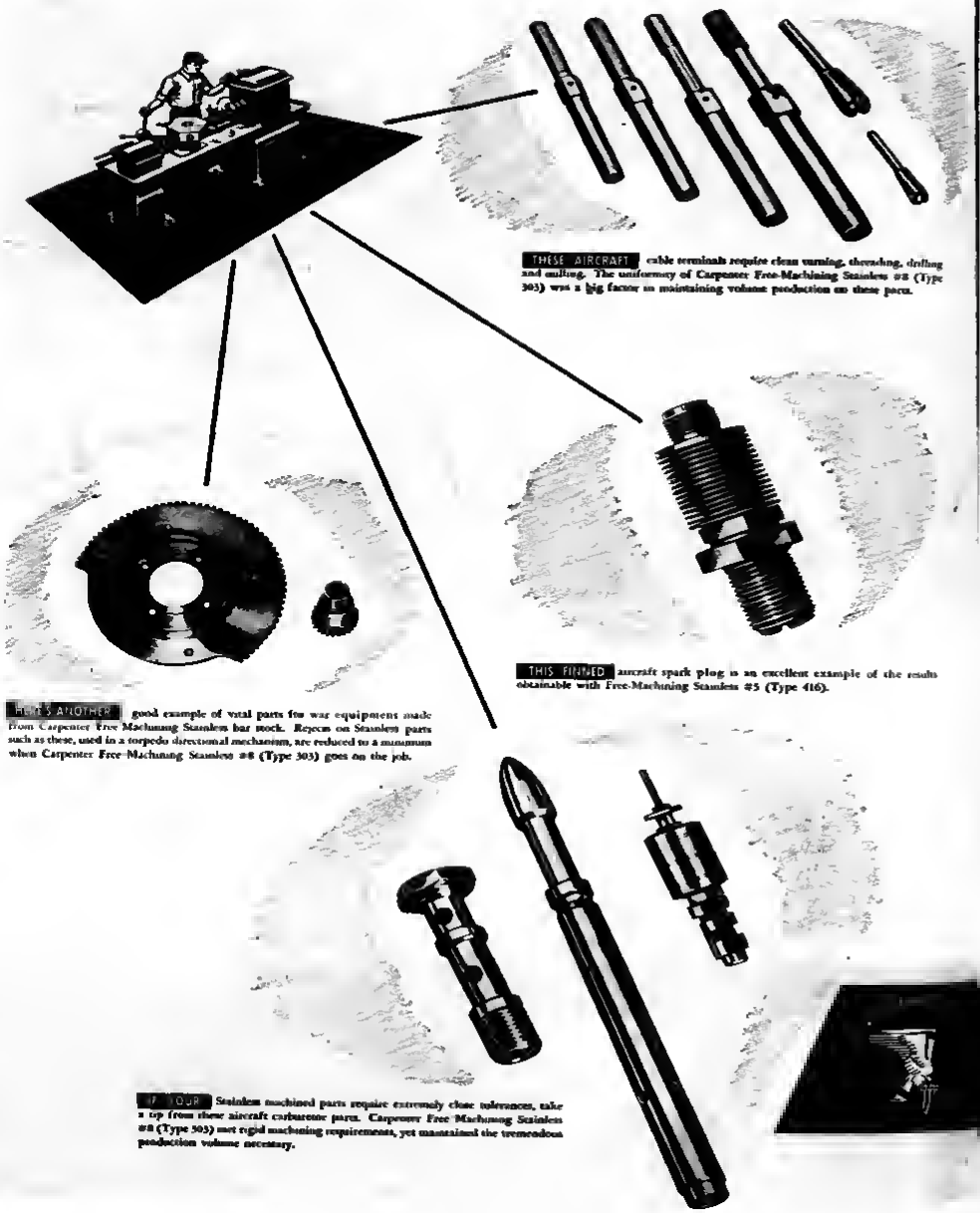
3. By re-engineering parts for quantity production.

4. By building complete airplanes and airships.

5. By extending facilities of Goodyear Research Laboratories to aid the solution of any design or engineering problem

GOODYEAR AIRCRAFT

GOODYEAR AIRCRAFT CORPORATION
Akron, Ohio - Litchfield Park, Arizona



THESE AIRCRAFT cable terminals require clean turning, threading, drilling and milling. The uniformity of Carpenter Free-Machining Stainless #8 (Type 303) was a big factor in maintaining volume production on these parts.

HERE'S ANOTHER good example of vital parts for war equipment made from Carpenter Free Machining Stainless bar stock. Rejects on Stainless parts such as these, used in a torpedo directional mechanism, are reduced to a minimum when Carpenter Free-Machining Stainless #8 (Type 303) goes on the job.

THIS FINNED aircraft spark plug is an excellent example of the results obtainable with Free-Machining Stainless #5 (Type 416).

IF YOUR Stainless machined parts require extremely close tolerances, take a tip from these aircraft carburetor parts. Carpenter Free Machining Stainless #8 (Type 303) met rigid machining requirements, yet maintained the tremendous production volume necessary.

YOU GET CORROSION RESISTANCE

PLUS

EASY, LOW-COST MACHINING

WITH CARPENTER STAINLESS

IF YOU'RE like a lot of product designers we know, you've said to yourself; "Of course, I'd like the corrosion protection and other advantages of Stainless for my new or redesigned products. But what about the machining cost?"

Our answer is "Try Carpenter Free-Machining Stainless and then take another look at the cost sheet." Others have found by using Carpenter Free-Machining Stainless that they can speed output, cut rejects and often eliminate further finishing operations.

Here's why. Carpenter Free-Machining Stainless bar stock is consistently uniform. It cuts free and clean and works the same, bar after bar. That means longer tool life between grinds, less tool breakage, lower tool costs. It means faster, easier production right down the line.

If you haven't already tried Carpenter Free-Machining Stainless Steels, be sure to do so. Through their use, you can obtain all the advantages of Stainless at less cost.

Your nearby Carpenter representative would like to tell you more about these easy-to-machine Stainless Steels. Why not call him in today?

THE CARPENTER STEEL COMPANY • 128 W. Bern St., Reading, Pa.

Many Other Products Offer These Advantages With Carpenter Stainless

- Strength and Rigidity
- Heat Resistance
- Weight Saving
- Freedom from Rust
- No Plating to Peel
- Ease of Assembly
- Longer Product Life
- Sales Appeal

Carpenter STAINLESS STEELS

AVIATION, March, 1945 18

Battle Turning Point

Courage is not enough unless it is backed by firepower... unless the right munitions in the right quantity reach the right place at the right time. This is a war of *supply* as much as it is a war of combat. At Bastogne, as in a hundred other moments in this war when the issue has been in doubt, the tide of battle was turned through the speedy delivery by air transport to our fighting men of shells and weapons which an hour before were hundreds of miles away. Douglas workers, builders of planes for the world's airlines yesterday and tomorrow, are working at full speed today building war transport planes which are turning the tides of battles.

Donald W. Douglas

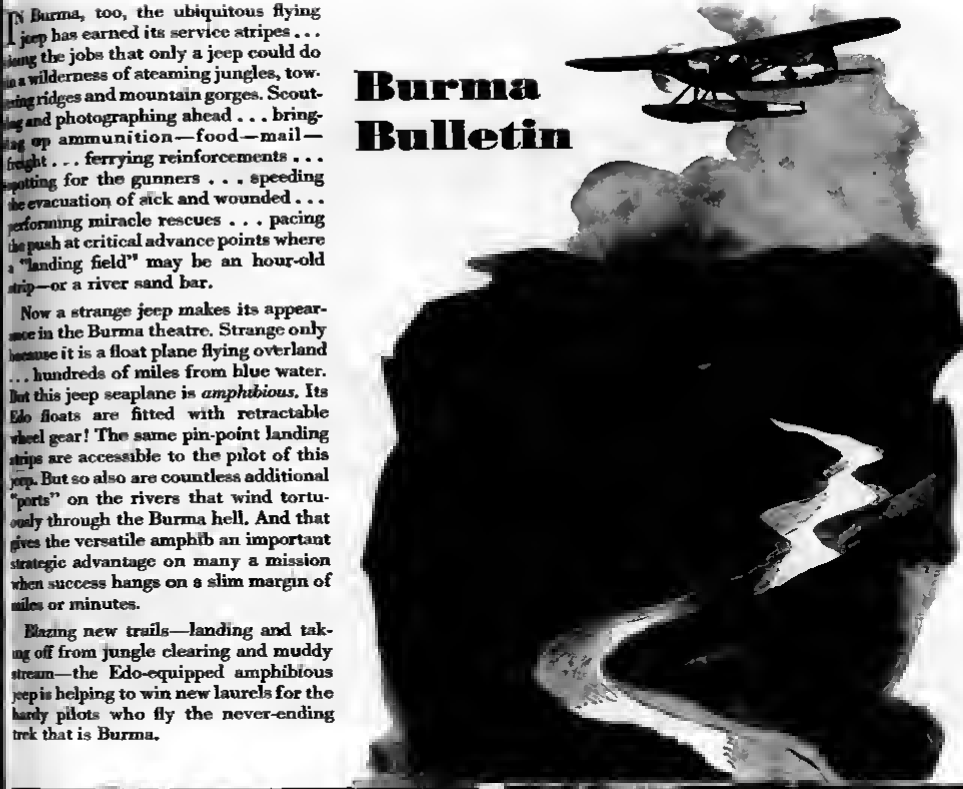
First AROUND THE WORLD — Douglas — QUALITY MARK OF AVIATION — First THE WORLD OVER

Burma Bulletin

IN Burma, too, the ubiquitous flying jeep has earned its service stripes . . . doing the jobs that only a jeep could do in a wilderness of steaming jungles, towering ridges and mountain gorges. Scouting and photographing ahead . . . bringing up ammunition—food—mail—freight . . . ferrying reinforcements . . . spotting for the gunners . . . speeding the evacuation of sick and wounded . . . performing miracle rescues . . . pacing the push at critical advance points where a "landing field" may be an hour-old strip—or a river sand bar.

Now a strange jeep makes its appearance in the Burma theatre. Strange only because it is a float plane flying overland . . . hundreds of miles from blue water. But this jeep seaplane is *amphibious*. Its Edo floats are fitted with retractable wheel gear! The same pin-point landing strips are accessible to the pilot of this jeep. But so also are countless additional "ports" on the rivers that wind tortuously through the Burma hell. And that gives the versatile amphib an important strategic advantage on many a mission when success hangs on a slim margin of miles or minutes.

Blazing new trails—landing and taking off from jungle clearing and muddy stream—the Edo-equipped amphibious jeep is helping to win new laurels for the hardy pilots who fly the never-ending trek that is Burma.



EVACUATING SICK AND WOUNDED WITH A STINSON L-1A EQUIPPED WITH EDO AMPHIBIOUS FLOATS

EDO Amphibious FLOAT GEAR
SERVES THE UNITED NATIONS

EDO AIRCRAFT CORPORATION
462 SECOND ST., COLLEGE POINT, L. I., N. Y.

by Forging

How will recent developments in the use of forging techniques for forging so-called impossible-to-forge designs affect the post-war preference for your product? An ever-broadening technical knowledge concerning the **IMPROVEMENT OF METALS BY FORGING**, and the application of forgings, is available through our engineers who, throughout 31 years of forging production experience, have helped to make marked improvements in many products. Ask a Steel Improvement Forging Engineer how to utilize the strength and toughness of forgings to increase preference for your products.

FINEST of the FINE

BEST in the world—that's American aviation. Years of development have made it so.

Finest of the fine—that's Wolf's Head Oil. It's the product of years of research and development.

Ever since the days of barnstorming pilots, Wolf's Head engineers and aviation designers have worked in close cooperation. As planes have been bettered, and requirements have been raised, Wolf's Head has advanced accordingly. Conversely, steady refinements in Wolf's Head Oil have contributed much to the progress of flying.

Today, Wolf's Head is preferred by leading manufacturers of airplane engines for critical tests and break-in runs. It is shipped round the world for United Nations planes.

Tomorrow's airplanes may need even better oils—but Wolf's Head, as always, will be ready to make them. Whatever the requirements of aviation may be, Wolf's Head will continue to meet them in offering an aviation oil refined from the "finest of the fine" pure 100% Pennsylvania crude. Wolf's Head Oil Refining Company, Oil City, Pa.—New York 10, New York.

WOLF'S HEAD

100% PENNSYLVANIA

AVIATION OIL

P.G.C.O.A. Permit No. 6

A BETTER WAY TO TRANSMIT POWER

Here is a way to transmit power through congested space and produce linear motion at a distant point. It is with Lear Flexible Shaft systems. These systems can provide power to a space so small that it would not permit the use of even the small Lear Actuator.

In these systems, a Lear Power Unit is mounted where space permits and Lear Flexible Shafting carries the force to points where motion is required. Here Lear Screw Jacks convert the spinning motion into a powerful thrust or pull.

Lear Flexible Shafts are not like any you've seen before. They reliably handle power rotating either way. They're strong. Installation is easy and not expensive. They have no exposed moving parts. They can do the work of solid shafts, torque tubes, pulleys, linkages, sprockets, belts and chains.

The days to come are going to bring a lot of difficult power-transmission and control problems in all kinds of industry. And probably Lear Flexible Shaft systems will solve many of them.

So we're telling you about them now. If you're faced with a problem such as we've indicated, please let us know. Our engineers are eager to share their experience with you.

Lear INCORPORATED

LEAR, Incorporated—Piqua, Ohio—formerly Lear Avia, Inc.

See this Film . . .

the dramatic story of ALUMINUM

HERE is a 34-minute educational film on aluminum that is jam-packed with interesting information on its processing . . . from the mining of bauxite, refining it to alumina, reducing the oxide to metal . . . right on through to the rolling of sheet, rod and bar . . . and the manufacture of fabricated parts.

This film, titled "A Recital of Faith," portrays the great advances in aluminum technology during the war years, and the infinite possibilities for aluminum in the post-war world.

Underlined is the part Reynolds Metals is prepared to play in co-operation with engineers and manufacturers who are now using, or plan to use aluminum, and the new lightweight, high-strength aluminum alloys.

Showings easily arranged

Every audience that has seen "A Recital of Faith" has praised it in glowing terms. It is now available, without charge, for showings before technical groups, engineering societies and manufacturers . . . 35 mm. or 16 mm.

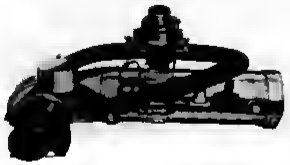
For full information, just write Reynolds Metals Company, Aluminum Division, 2500 South Third St., Louisville 1, Ky. On your letterhead, please.

REYNOLDS METALS

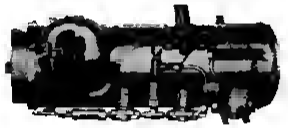
REYNOLDS ALUMINUM

Constant Development

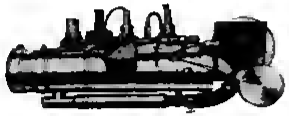
OF JANITROL AIRCRAFT HEATERS!



Janitrol Aircraft Heaters equipped with 50,000 B.t.u. output *combustion air regulator* to compensate for atmospheric densities. Operates efficiently at highest flying altitudes. Fuses provided for ground and flight operation.



This 50,000 B.t.u. Janitrol Heater is equipped with a *combustion air relief valve* to compensate for changes in volume of air, due to changes in plane speeds.



For engine and cockpit warming, glass-de-frosting, and other heating functions on the ground, Janitrol heaters are fan equipped. 15,000 B.t.u. model illustrated.

Other models now in production provide capacities from 15,000 to 125,000 B.t.u. per hour output, larger capacity heaters will soon be available.

Portable, self-contained ground heater furnishes heat for engines, hangars, work shops, to dry out condensation, and many other purposes. Operates at sub zero temperatures.

THE Janitrol Aircraft Heater is the latest development in a long list of important heating advances pioneered by Surface Combustion engineers. In United Nations' airplanes all over the world, this famous "Whirling Flame" heater is providing quick, dependable heat at *all altitudes* . . . at varying speeds . . . at temperatures down to 70 *below* zero.

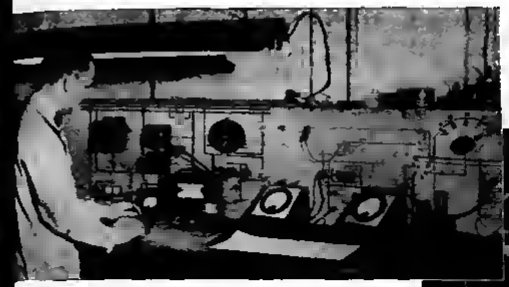
These highly efficient Janitrol heaters are constantly tested, performance reports are carefully studied, and through continued research, new refinements in design and control equipment are still improving operation. Surface Combustion engineers are not satisfied with producing the most advanced aircraft heaters, but still seek even greater perfection in design and performance.

That's why for over 30 years, Surface Combustion has always meant "*research* in combustion" . . . *constant development* that has brought forth *more* technical improvements in heating methods than have come from *any other one company*.

Today, Surface Combustion engineers are applying these aircraft heaters to meet the heating requirements of other forms of transportation—they are also continually developing new adaptations of the "Whirling Flame" for buses, trucks, cars, trailers, boats, trains and other unusual heating problems. These heaters operate in similar manner to the aircraft heater, burning liquid fuel, and featuring compactness, low weight and adaptability wherever a portable or fixed source of heat is required.

The results of our experience and the unique facilities of this Company are available to help you work on your particular problems. For further information write Surface Combustion, Aircraft Heater Div., Toledo 1, Ohio.

Janitrol



TEST STAND WITH 15,000 B.T.U. HEATER. This equipment is used for ignition tests, fuel flow checks, and performance tests.

ELECTRICAL TESTING BENCH . . . used in conducting life tests and performance tests on heaters.

ON IGNITION TEST is the 50,000 B.t.u. heater in foreground. In background, efficiency and performance tests are being made on a 125,000 B.t.u. unit.

PREPARATION FOR COLD ROOM TEST. Fuel system on this 40,000 B.t.u. heater is arranged to test two different types of pumps.

MAKERS OF:

JANITROL Aircraft and Portable Heaters • JANITROL Gas-Fired Forced Air and Gravity Furnaces, Unit Heaters and Conversion Burners for commercial, industrial and residential heating • S. C. Industrial Heat-Treating Furnaces, Special Atmosphere Generators and Industrial Gas Burners • KATHABAR Humidity Control Systems

Manufacturing Plants at:

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Simmonds Controls *provide a Soundly Engineered Solution to Every Push-Pull Problem*

LET SIMMONDS ANALYZE YOUR CONTROL PROBLEM

Simply submit the basic requirements, as follows:

- What does the control operate?
- LOAD: Compression (lbs.) Tension (lbs.)
- VIBRATION CHARACTERISTICS
- TEMPERATURE CONDITIONS
- PRESENT SYSTEM
- FLEXIBLE OR RIGID HOUSING?

Make sketches of top and side views of installation. Use regular graph paper and indicate unit of measure.

SIMMONDS EQUIPMENT FLIES WITH EVERY TYPE OF ALLIED AIRCRAFT

Automatic Engine Controls — Push-Pull Controls
Spark Plugs — Hydraulic Accumulators
Hydraulic Pumps — Chronometric Tachometers
Fasteners and Clips of Specialized Design

WHETHER your remote control problem involves the coordination of a blimp's engine controls...the measuring of a locomotive's operating efficiency...or the limitless other examples in the wide range bracketed by these extremes — a ready solution is offered by the use of precision-built Simmonds-Corsey Push-Pull Controls.

Developed originally for aircraft uses, where dependability and efficiency are at a high premium, and proved in more than half a million installations, Simmonds controls offer to design engineers a simple but advanced system in the field of mechanical remote control, replacing the anciquated pulley and cable and rod and bellcrank arrangements. For a complete engineering analysis of your push-pull problems, send data concerning your requirements, as suggested in the panel at left, to the nearest Simmonds office today.

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Simmonds PRODUCTS INC.

BRANCH OFFICES: DAYTON • WASHINGTON • GLENDALE, CAL. • MONTREAL
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That's a sample of what the "Propeller with a Brain" will do for your private plane of tomorrow

No Sir! There's nothing like Aeromatic! It lets your plane and engine deliver automatically—*as no other propeller can*—ALL the performance that's built into them.

That's why an Aeromatic means one-fourth shorter takeoff runs. One-third higher rate of climb. Greater cruising range and speed. With minimum fuel consumption and engine wear. And Aeromatic means long glides for happy landings—with an instantaneous change of pitch for a quick pickup if you overshoot the field or landing strip.

More than that, the Aeromatic requires no instruments . . . no controls . . . nothing extra for you to watch or do. It's the one and only self-acting variable pitch propeller . . . the one and only propeller that automatically assumes the correct pitch for peak performance under any and all conditions of flight.

If you fly, or plan to fly, you'll want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder, containing a diagram of the "brain" in an Aeromatic Propeller, don't hesitate to write to Aeromatic, 206 Scott St., Baltimore 3, Maryland. We'll be glad to bear from you.

...a Brain for Tomorrow's Plane

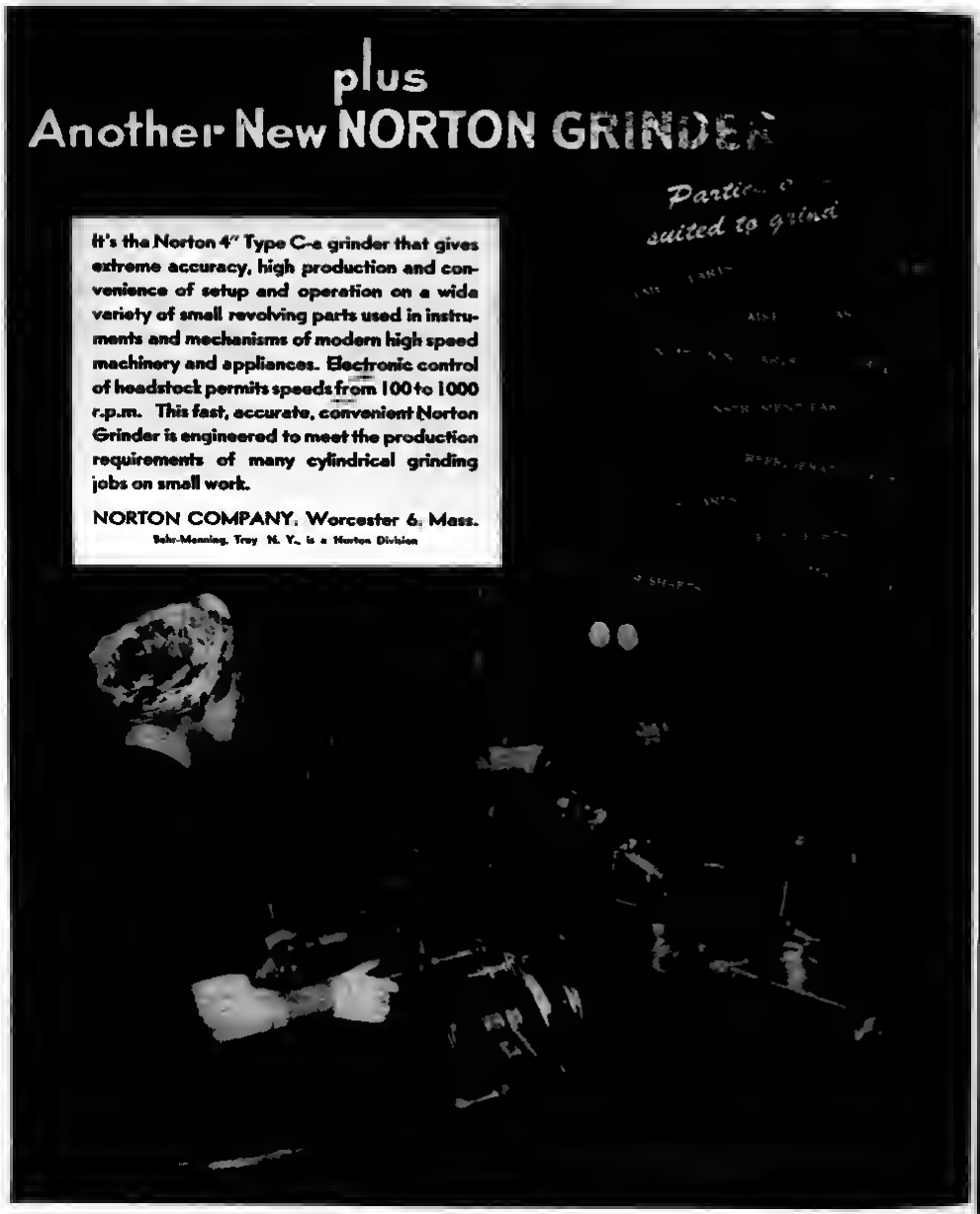
Aero matic

Air Controlled ...tic Propeller

KOPPERS COMPANY, Inc., ...RTLETT-HAYWARD DIVISION

Licensed under patents of EVEREL Propeller Corporation

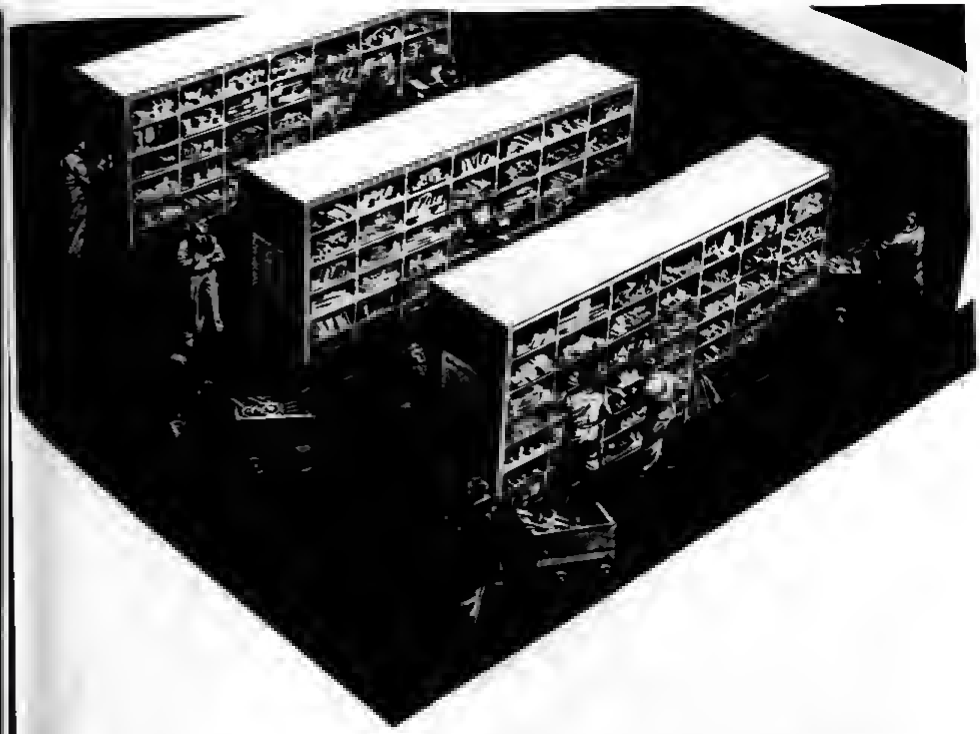
plus
Another New NORTON GRINDER



It's the Norton 4" Type C-e grinder that gives extreme accuracy, high production and convenience of setup and operation on a wide variety of small revolving parts used in instruments and mechanisms of modern high speed machinery and appliances. Electronic control of headstock permits speeds from 100 to 1000 r.p.m. This fast, accurate, convenient Norton Grinder is engineered to meet the production requirements of many cylindrical grinding jobs on small work.

NORTON COMPANY, Worcester 6, Mass.

Behr-Manning, Troy N. Y., is a Norton Division



Ready when you are...

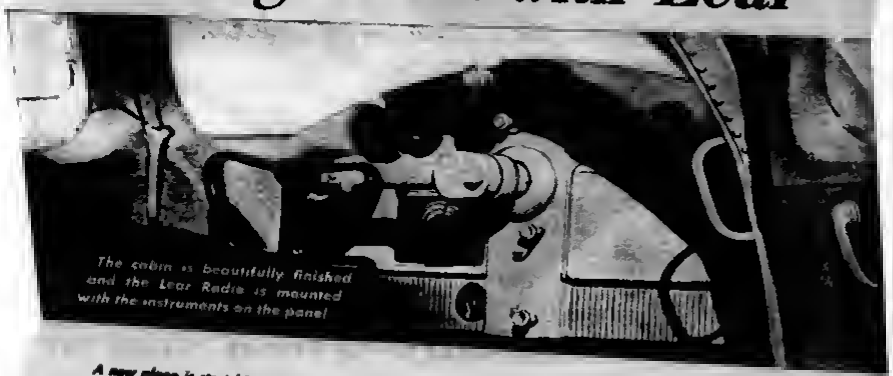
Since 1927, we have been serving the aviation industry . . . at first, solely as a reliable source of off-the-shelf general supplies and equipment. Later, also as producer of an extensive line of specialty accessories of our own design and engineering. For the past few years our business has been confined largely to production to meet military requirements. To a restricted degree, it has been possible to maintain relationship with our peacetime trade—private pilots, airlines, aviation schools, fixed base operators, hangar shops, wholesale and retail outlets. But today, conditions make it possible for Air Associates once again to serve private and commercial aviation completely—with bigger stocks and better facilities than before. If you require anything in aeronautical supplies or equipment—shipped anywhere—for prompt attention and proper prices, get in touch with Air Associates!

• AIR ASSOCIATES, INC.

TETERBORO N. J. ... *BRANCHES* CHICAGO, DALLAS, LOS ANGELES ...
ENGINEERS & MANUFACTURERS OF AIRCRAFT SPECIALTIES ...
SUPPLIERS OF ALL TYPES OF MATERIALS TO THE INDUSTRY SINCE 1927

Republic Aviation Corporation's new postwar amphibian flies with Lear Radio. This experimental model is Lear-equipped and all tests have been flown with it

Looking Ahead with Lear



The cabin is beautifully finished and the Lear Radio is mounted with the instruments on the panel

A new plane is stretching its wings. Kin to the Army's famous fighter, Republic's Thunderbolt Amphibian will make its bid as the postwar personal plane.

Grouped with the instruments on its nose panel is a Lear Aircraft Radio. For Republic knows well the long successful history of Lear in producing fine radios for the exacting needs of flying.

Since 1930, Lear has been a specialist in fine aircraft radio instruments and direction-finding equipment. They have won a reputation for being light, keenly sensitive and unusually dependable.

Of course, all Lear production now goes only where Uncle Sam says. But aircraft operators can look ahead to the days when Lear aircraft equipment, improved and developed by its work in war, will again be available.

Radio Division: Grand Rapids 2, Michigan
Aircraft Radio Sales: 1860 Broadway, New York 23, N. Y.
West Coast Subsidiary: Lear, Inc. of Calif.
1010 N. Highland Ave., Los Angeles 38, Calif.

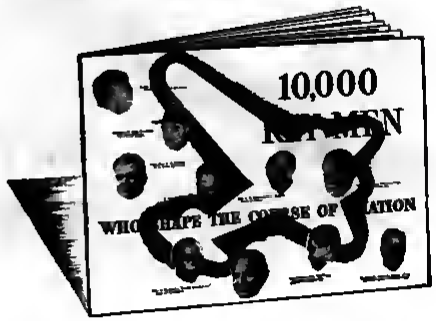
Formerly Lear Avia, Inc.

Lear INCORPORATED

Three New Booklets About Aviation Marketing

Air transport has joined the rail, marine and motor transportation industries as one of our great public carriers. Read the story of your business opportunity in this swiftly expanding market. Coupon below.

AIR TRANSPORT — strictly transportation



Who are the 10,000 key men of aviation? What are their functions? Their buying influences? With pictures, names, titles and companies, this 24-page book identifies the men who shape the course of aviation. Use the coupon.

AVIATION NEWS — aviation's only weekly

How to unscramble the confused aviation advertising picture. A clear guide to the fundamental marketing requirements of aviation. For your copy, check the coupon at right.

AVIATION — for foundation market coverage

FREE to interested sales and advertising executives

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Please send me the Advertising Studies checked below:

- ☐ The Builders of Our Swiftest Growing Transportation Industry
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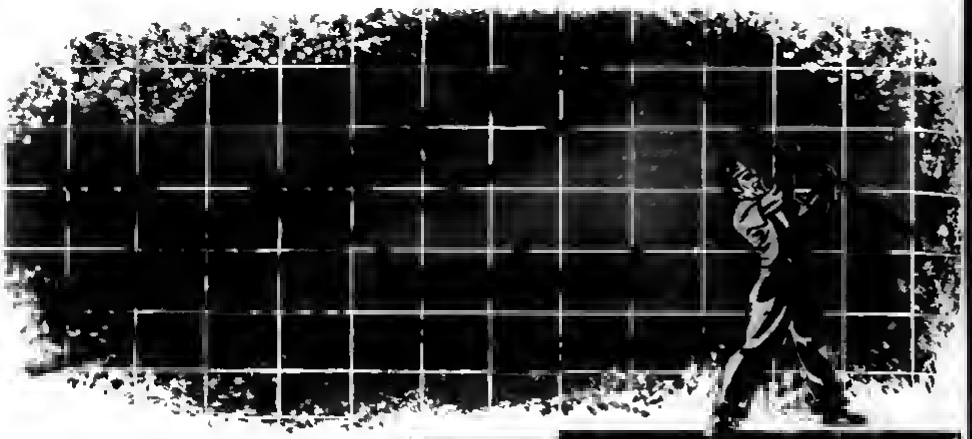


Walker-Turner Machine Tools have effected remarkable savings in war plants. Their wide range of operating speeds permits selection of optimum (most economical) cutting speed for every material. Simple, easy operation makes every man-hour more productive. Streamlined flexibility permits economical tooling set-ups. Low price and low power consumption keep capital investment and operating costs at a minimum.

Use Walker-Turner Machine Tools for the many jobs within their range and reserve heavy equipment for heavier work.

Walker-Turner Co., Inc., Plainfield, N. J.

METALS

Fast positioning and wide range of speeds make W-T Radial Drills ideal for this job at the plant of a large aircraft builder.

WOOD

W-T Radial Saw cross-cuts, rips, dadoes, miters, rouls, tenons. Also available in metal-cutting model.

PLASTICS

Speed range from 61 to 5300 s.f.m. in this W-T Band Saw cutting Plexiglas bomber nose at Rohm & Haas

CERAMICS

W-T 15" Drill Press has high speeds and spindle stability for fine drilling at General Ceramics plant.

ALUMINUM BRAZING VS. SOFT SOLDER

A heat transfer unit is only as strong as the bond that fastens its tubes to header plates or shell. The soft solder used for sweating copper units is low in resistance to temperature, pressure, vibration and shear. Silver solder or other high-melting-point solders can't be used because they anneal and weaken the copper at the soldering point.

ADVANTAGES OF ALUMINUM BRAZING

Clifford's discovery of the long-sought method of brazing thin-walled aluminum tubes brought four recognized advantages to heat-transfer engineers of the USAAF.

1. A saving of ⅔ the weight of copper in the same size and shape.
2. Heat-treatable aluminum tubes that don't break down under working temperatures as high as 275°F. instead of copper tubes that gradually anneal and weaken.
3. Heat-treatable aluminum alloy header plates, shells and other parts that stand up under much higher temperatures and pressures than other metals commonly used in heat transfer units.
4. An aluminum alloy bonding material capable of withstanding temperatures, pressures and strains several times higher than soft solder's limits.

Performance records of Clifford Feather-Weight Oil Coolers and Coolant Radiators in several types of USAAF fighters verify these advantages.

POSTWAR APPLICATIONS

Although Clifford's production is now 100% in war work, inquiries and suggestions about postwar applications of all-aluminum heat-transfer units to automotive, heating, cooling and ventilating fields will be given full consideration. *Save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 562 E. First St., Boston 27, Massachusetts.

IN HYDRAULICALLY-FORMED BELLOWS only the fittest survive

Of all the tests Hydron Bellows must pass before they go to work for you, the first is the most severe. That's the test of the manufacturing process that gives them shape . . . hydraulic forming.

Figure it out for yourself. Take a paper-thin metal tube. Force the walls transversely between the plates of a collapsible die *under internal hydraulic pressure amounting to several hundred pounds per square inch.* Tubes with imperfections or flaws can't take it. They are automatically rejected by the process.

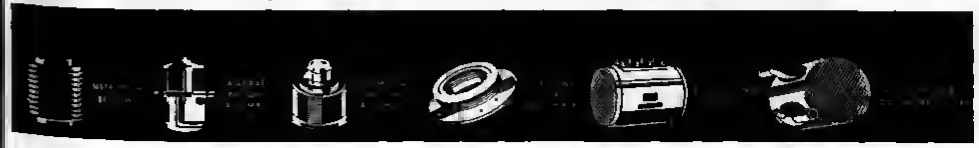
That's why every Hydron Bellows is a sound metallurgical specimen . . . with no seams, tool marks or hidden flaws. And, further, that's why each Hydron Bellows has plenty of flexes left in its system when less severely tested bellows have quit on the job.

Naturally, when Clifford builds these perfect Hydron Bellows into assemblies for temperature and pressure control or for shaft seals and other exacting uses, every precaution is taken to preserve that inborn perfection.

Because the same men who produced industry's first hydraulically-formed bellows — Hydron — are still on the job, Clifford is equipped, perhaps better than anyone else, to supply you with these uniform, pretested hydraulically-formed bellows either as such or in highly-engineered bellows assemblies. *First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Co., 561 E. First St., Boston 27, Massachusetts.

CLIFFORD *for* **OIL COOLERS AND COOLANT RADIATORS**

HYDRAULICALLY-FORMED BELLOWS HYDRON



What's a Sperry TR doing up here?

● Photos from a movie of actual operations at an AAF bomber base in England.

THAT FELLOW in the uniform up on the bomber is one of the many Sperry Service Engineers on duty overseas—Technical Representatives with the Armed Forces.

These men know their gyroscopes! They help keep Sperry equipment, gyroscopic and otherwise, at the peak of condition . . . often make check flights in the lead plane before bombing missions . . . perform hundreds of vital tasks in support of combat units.

Here at home scores of other Sperry Service Engineers work at top speed to help keep the equipment flying—and their tasks are no less vital. *In all, some 135 Sperry Service Engineers devote their full time to aeronautics.*

Sperry has always taken pride in its complete *follow-through* service for Sperry devices. The Service Engineers who see that no Sperry product ever becomes an "orphan" are highly trained technical men. *After* the war, they'll be busy following through on the instruments which we will produce for peacetime aviation . . . busy in all corners of the world.

THEY WILL BE responsible for proper installation of Sperry equipment . . . for instructing in proper operation and maintenance . . . for servicing, should trouble occur. And for keeping our Research Laboratories informed about the performance of equipment in the field, thus helping to make Sperry devices ever finer.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.
Division of the Sperry Corporation

★

LOS ANGELES · SAN FRANCISCO · NEW ORLEANS
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GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

Greer GOVERNMATIC *Propeller Governor* TEST MACHINE

- *Simulates actual flight conditions.*
- *Variable speeds at variable displacements.*
- *Simple, fast, automatic pushbutton operation.*

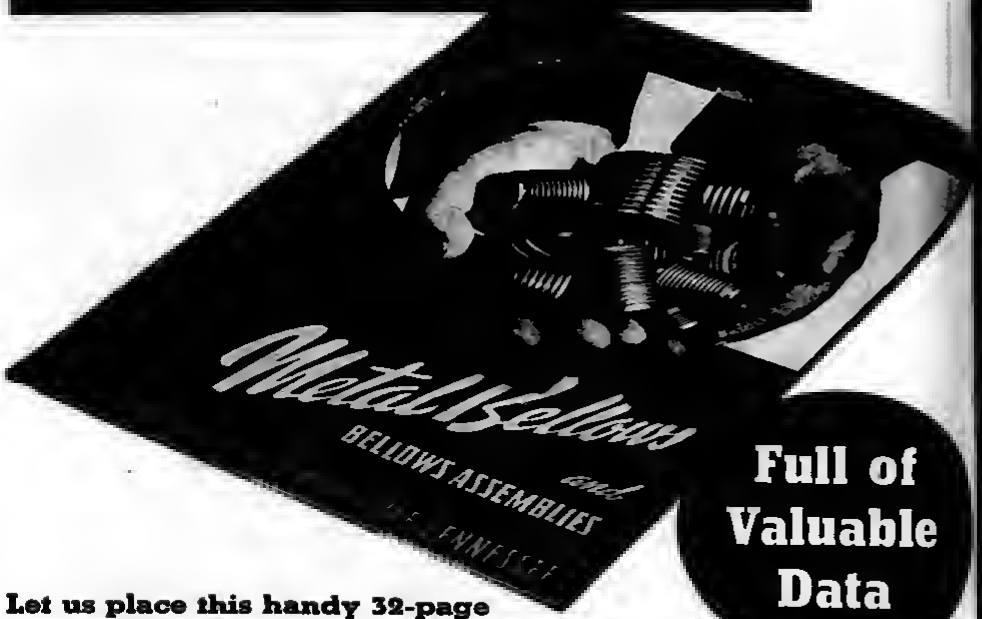
Other Features

★ Automatic operational features eliminate need for technical skill.

★ [illegible] to re-

Featherin[illegible] just as it [illegible]

Just say the word...*



Full of Valuable Data

Let us place this handy 32-page reference book on your desk without charge

ALL ABOUT BELLOWS, bellows assemblies, and bellows devices. How they are made, what they do, life expectancies, etc. Complete information on physical characteristics, sizes, metals, assemblies, applications, etc., etc. Included are many useful time-saving tables—equivalents, conversion equations, temperature conversions, and physical data on approved charges; also pages of drawings detailing design and construction, together with photographs of special bellows and interesting assemblies.

*Write on your letterhead: "YES, I'd like to receive a copy of the new Fulton Sylphon Bulletin EA-1300"

NEW MOVIE—"The Story of Metal Bellows" is available to interested executives and organizations.

FULTON SYLPHON

Trapper to Trading Post

. . . in Minutes instead of Months

Despite the development of modern fur farms, much of the world's supply of fine furs still comes from wild animals—trapped in remote areas in the Arctic. And many a trapper's cabin is months away from a trading post by dog team—the only transportation available

But such points—no matter how remote—will be easily accessible by helicopter—postwar. Operated by professional pilots, it will provide swift, safe transportation and cargo service to many locations heretofore accessable only by dog team, pack mule, portage and canoe.

And, on the basis of *low cost* per *ton-mile*, the helicopter is almost unrivaled as a cargo carrier to inaccessible points. For it requires neither roads, rails, nor landing facilities. Therefore, its commercial applications for both cargo and passenger service to isolated areas—in addition to its utility for short haul and shuttle service—are almost endless.

At McDonnell, *right now*, we're doing everything possible to turn out more planes, parts, and plastics for war. But we're engaged too, in comprehensive helicopter development work... work which will make available to you and your organization *postwar*—this swift, safe, economical and highly adaptable transportation service.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES • PARTS • PLASTICS ★ SAINT LOUIS-MEMPHIS ★

ESTABLISHED!!

The VINCO Master Inspection Dividing Head is now universally accepted as the most accurate final inspection instrument yet devised for checking the angular spacing of splines, gear teeth, master index plates, graduations, cams, etc. It is approximately seven years since the VINCO Dividing Head was introduced and today it is as well known in Russia, Australia and other countries as it is in the United States. We are naturally proud of this instrument, not only for its extreme accuracy (TWO SECONDS OF ARC OR TWO PARTS IN 1,296,000) but because it has been such an important factor in increasing the production of those vital parts, involving angular spacing, that are so essential in modern war materiel. We will welcome your request for more detailed information.

VINCO CORPORATION 5865 SCHAEFER HIGHWAY DETROIT 27, MICHIGAN SALES OFFICES NEW YORK CHICAGO CLEVELAND

MILLIONTHS OF AN INCH FOR SALE BY VINCO

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangential Radius Gage • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Rotary Fixtures • Special and Index Fixtures • Hydraulic Systems • Control, Utilization and Distribution Units • Engineering, Design and Development

RYAN PRODUCTION ENGINEERING DEVELOPMENT NO. 28-38-18

Faster, Lighter Aircraft, Greater Poy Loads through New Techniques in Processing Aluminum Alloys...

How to develop airplanes capable of carrying greater pay loads at higher speeds by reducing structural weight? That's the aeronautical engineer's basic problem.

To accomplish this end could a metal be found which had the lightness of Aluminum and the strength of steel? Yes, Aluminum alloys could be post-aged to give them this much desired strength. But, the process so reduced the corrosion resistance of the metal that full advantage could not be taken of this development.

Ryan metallurgists tackled the problem and came up with a procedure which yields a light corrosion-resistant alloy with the strength of low carbon steel.

Ryan engineers have been *first* to make full use of this weight-saving development in the design and construction of aircraft. This advantage, which adds to the deadliness of American warplanes, will be equally valuable to the peacetime planes of the future.

THE PROBLEM: How to take advantage of the extra strength imparted to Alclad 24-S by the post-aging process. The strength of this metal, composed of an Aluminum alloy covered with a thin deposit of pure Aluminum, may be increased by post-aging. However, this has always been accompanied by a loss in corrosion resistance which prevented aeronautical engineers from completely utilizing this advantage. The aging reduced the galvanic potential between the alloy and the clad Aluminum and removed the electrolytic protection it afforded.

THE SOLUTION: Ryan research found a way to obtain the strength increase and maintain high corrosion resistance. The Alclad is placed in an oven and held to a temperature of 365° F. for ten hours. This induces a copper precipitation and raises the tensile strength at least 26%. Then the corrosion resistance is restored by anodizing a thin layer of oxide on the surface and spraying it with a zinc chromate primer.

THE ADVANTAGES: By ordering specified stock, post-aging at carefully controlled temperatures and anodizing and priming, Ryan has created new possibilities for Aluminum alloys. The entire aircraft industry may now have the benefit which this metal, with Aluminum's lightness and steel's strength, gives to every designer and builder of airplanes.

RELY ON RYAN TO BUILD WELL

1922-1945

RYAN Airplanes

Ryan Aeronautical Company, San Diego — Member, Aircraft War Production Council, Inc.

DESIGNERS AND BUILDERS OF NAVY FIGHTING PLANES AND EXHAUST MANIFOLD SYSTEMS

It is reported that . . . . . .

Helicopters capable of lifting as much as 15 tons and of carrying 35 or 40 persons, plus mail and baggage, are believed by one expert to be within the realm of possibility. *Col. H. F. Gregory, Engineering Division, Materiel Command, U.S.A.*

get ready with **CONE** for tomorrow

A pilot flying between South America and Africa recently flew across the Atlantic four times in three days. *Office of War Information.*

get ready with **CONE** for tomorrow

One of the country's leading department stores has scheduled a Postwar Fair for next May. Manufacturers are invited to participate, but space is not for sale. *R. H. Macy, New York City.*

get ready with **CONE** for tomorrow

Salvage apparatus for extremely great ocean depths has been patented. Its powerful jaws are guided by television apparatus. *Patent 2,355,086.*

get ready with **CONE** for tomorrow

Because of the high cost of converting ordinary electric power into high-frequency power, it is not at present believed that electronic cooking is practical for household use, although in commercial food processing it has great possibilities. Typical of its application to food processing is the recent experiment with packaged pancake flour in which the temperature inside the package was raised to 130 degrees in less than 30 seconds, completely destroying all insect life. *Scientific American.*

get ready with **CONE** for tomorrow

Rubber scientists think that they have solved the problem of ice on airplane propellors by the use of a three-ply rubber covering, the center layer of which is an electric heating element. *Goodyear Tire & Rubber Co.*

get ready with **CONE** for tomorrow

An inter-continental highway between Alaska and Siberia, by way of a tunnel under Bering Strait, is being seriously considered. *Alaska Highway Committee of Pacific Northwest Trade Association.*

Experimente are being made with plastic bottles blown in the same molds used for glass. *Advertising & Selling.*

get ready with **CONE** for tomorrow

A total of 29 dams is planned for the Pacific Northwest, the first six of which will cost 226 million dollars and provide power and water for a population of 2 million. *Engineering & Mining Journal.*

get ready with **CONE** for tomorrow

A new method of dyeing acetate rayon is said to make the colors practically fade-proof. *North Carolina Fabrics Corporation.*

get ready with **CONE** for tomorrow

A large airplane manufacturer has produced an experimental model of a 200 pound automobile. *Science Digest.*

The first commercial model of a sound-on-tape machine has been made and is said to play continuously for eight hours *Fonda Corporation.*

get ready with **CONE** for tomorrow

The use of music in factories is expected to create jobs for 26,000 musically trained broadcast directors. *Science News Letter.*

get ready with **CONE** for tomorrow

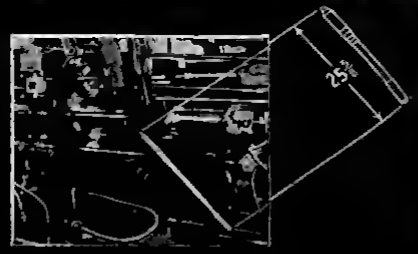
A new device that opens and closes a window thermostatically is waiting for release of materials to go into production. *E. O. Gillen, 1713 N. Water St., Milwaukee.*

get ready with **CONE** for tomorrow

A new eight-engined flying freight boat with 320 foot wing span is expected to be ready about the first of the year. *Howard Hughes, Aviation News.*

get ready with **CONE** for tomorrow

A new ingredient added to the Army's soap is said to make it work effectively in any sort of water, salt, fresh, cold, hot, soft, or hard. *E. I. duPont de Nemours & Co. Inc.*



Check the Features of LINCOLN

FLEX-O-MATIC Air-Couplers and Nipples

Automatic Coupling – push on... pull off. Designed to allow greater air flow, they give high efficiency. Flex-O-Matic Couplers are available for immediate delivery from any Lincoln Wholesaler.

No. 11660 Standard Flex-O-Matic Air Coupler Nipple. ⅜" PT Male.

No. 11661 Standard Flex-O-Matic Air Coupler Nipple. ¼" PT Female.

No. 11659 Standard Flex-O-Matic Air Coupler Nipple. ⅜" PT Male.

No. 818 Standard Flex-O-Matic Air Coupler 1/4" PT Female Inlet. Overall Dimensions, Length 2-31/64", Diameter 1-6/64".

Standard Flex-O-Matic This coupler is ideal for small pneumatic tools and all operations requiring the coupling and uncoupling of an air hose. Nipples are available in sizes and types as noted below. Here are a few of the features:

1. LOCKING SLEEVE—holds pins inward when nipple is inserted—holding coupler firmly in place.
2. BUSHINGS—holds pins outward when locking sleeve is drawn back.
2. LONG NIPPLE—greater surface contact assures more positive alignment.
4. ONLY ONE PACKING—seals coupler to nipple and provides seal for check valve when nipple is removed.
5. CHECK VALVE—large passage for free air flow.

VOLUME TYPE Flex-O-Matic Coupler and Nipples

No. 11858 Volume Flex-O-Matic Nipple. ⅜" PT Female.

No. 818 Volume Flex-O-Matic Air Coupler 3/8" PT Female Inlet. Overall Dimensions, Length 3-1/4", Diameter 1-1/2".

No. 11859 Volume Flex-O-Matic Nipple. ⅜" PT Male.

Where larger volumes of compressed air are required the Volume Type Flex-O-Matic Air Coupler and Nipples will prove more practical. Nipples are available in sizes and types as noted below. Here are a few features of this outstanding coupler:

1. LOCKING SLEEVE—holds pins inward when the nipple is inserted—also holds coupler firmly in place.
2. BUSHINGS—when locking sleeve is drawn back the bushing holds pins outward.
3. LONG NIPPLE—greater contact surface gives better alignment.
4. PACKING—a single packing seals coupler to nipple and provides seal for check valve when nipple is removed. Positively no air leakage.
5. CHECK VALVE—Big ports provide less restriction to air flow.
6. PROTECTING FLANGE—prevents coupler from accidental detachment. Assures coupler-nipple connection if coupler is dragged over rough floors.

If you use compressed air... use LINCOLN Flex-O-Matic Air-Couplers and Nipples

Write for Complete Information

LINCOLN

Pioneer Builders of Engineered Lubricating Equipment

The durability of Alcoa Aluminum skin on our war planes has earned the everlasting respect of fighter and bomber pilots and ground crews alike. They will look for it on their private planes of tomorrow.

This same strong, workable, lightweight, corrosion-resistant skin will be available to private plane makers.

Designing with Alcoa Alclad Aluminum skin will greatly reduce the number of parts... ribs, bulkheads, stringers. It will cut production costs and thus widen the market for private planes.

ALUMINUM COMPANY OF AMERICA, 2122 Gulf Building, Pittsburgh 19, Pennsylvania.

LOOK FOR ALCOA ALCLAD ALUMINUM WINGS AND FUSELAGE

ALCOA ALUMINUM

4 TOUGH JOBS

. . . and how to lick 'em with G-E Mazda Lamps

Proper use of better lighting can produce startling results . . . in better efficiency, in reduced spoilage, in more and faster production. Shown here are four typical industrial jobs, each much improved with better lighting from G-E Mazda Lamps. Ask your G-E Lamp Distributor for full details.

1 **Instant detection** of breaks in fine wire helps this plant keep production up, costs down. Correct lighting with G-E Mazda Lamps enables even unskilled workers to reduce errors and do more accurate work.

2 **Polished surfaces** often present tough inspection problems. Above, inspection of highly polished machine parts is made easier with low brightness, high footcandle lighting developed with G-E Mazda Lamps.

3 **Safety hazards** can be minimized with high level illumination. G-E Mazda Lamps provide uniform, efficient light sources to help operators see better, faster, more accurately.

4 **Fewer mistakes!** G-E Fluorescent lighting helps to hold shadows at an absolute minimum. It approaches actual daylight conditions with soft, cool, low-brightness illumination.

"To make G-E Lamps STAY BRIGHTER LONGER"
The constant aim of G-E Lamp Research

G-E MAZDA LAMPS
GENERAL ELECTRIC

Hear the G-E radio programs: "The G-E All-Girl Orchestra", Sunday 10:00 p. m. EWT, NBC; "The World Today" news, Monday through Friday 6:45 p. m. EWT, CBS; "The G-E Housepary," Monday through Friday 4:00 p. m. EWT, CBS.

BUY MORE WAR BONDS . . . AND HOLD

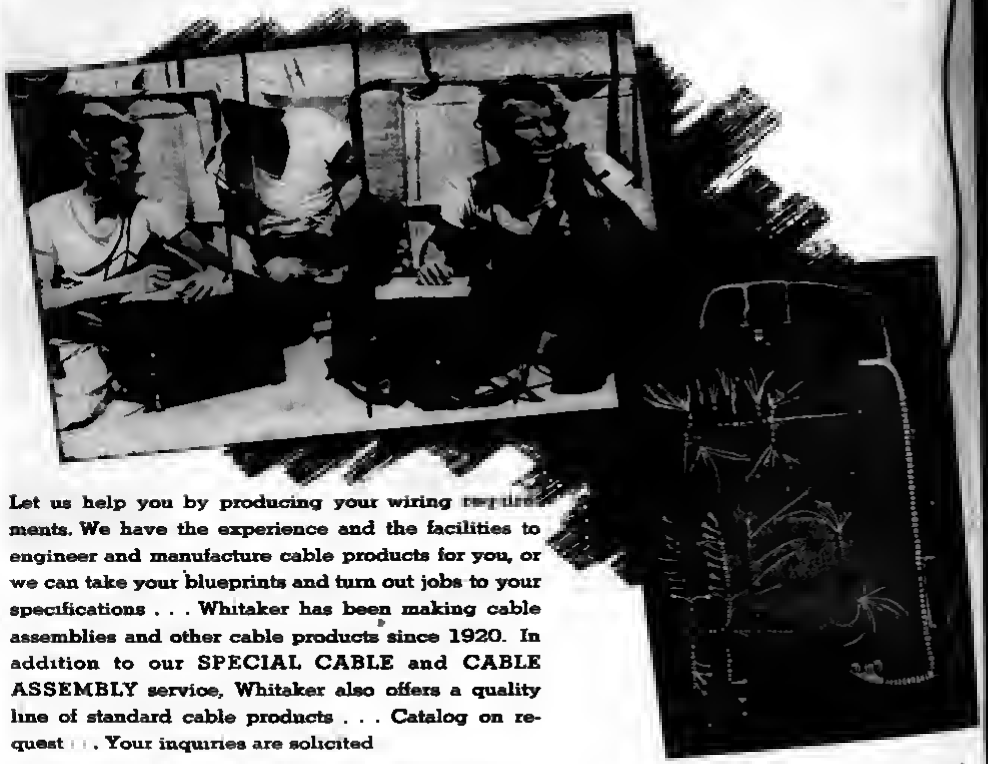
Planes that CARRY *their "landing strips"*

Emergency landings on rain-soaked jungle runways are not infrequent in today's global warfare. Even on such tough terrain, AEROLS (Cleveland Pneumatic shock-absorbing landing gear) protect the plane and pilot by helping insure a safe, smooth landing. • Today, AEROLS are contributing substantially to the efficiency of military planes; tomorrow, they will provide even greater comfort in the *age of flight.* • Our products, serving many major industrial fields, are mentioned below. Whatever your needs, Cleveland Pneumatic Tool engineers offer you the benefit of over 50 years manufacturing experience.

THE CLEVELAND PNEUMATIC TOOL CO., Cleveland 5, Ohio

Speed Final Victory! Buy MORE War Bonds

Whitaker Can Wire It



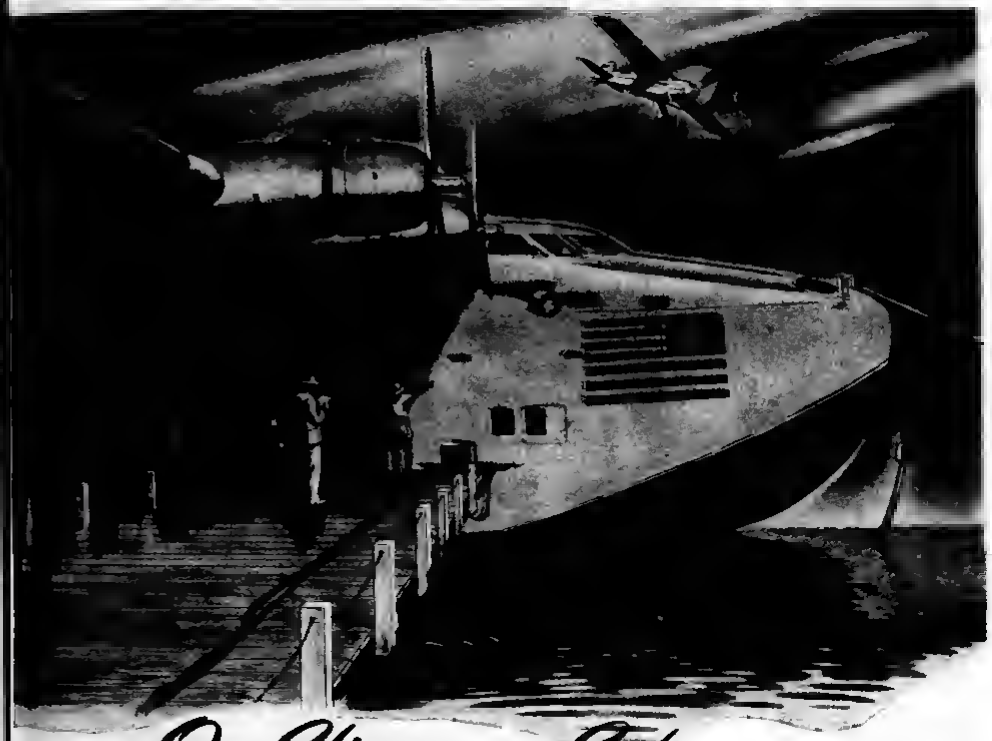
Let us help you by producing your wiring requirements. We have the experience and the facilities to engineer and manufacture cable products for you, or we can take your blueprints and turn out jobs to your specifications . . . Whitaker has been making cable assemblies and other cable products since 1920. In addition to our SPECIAL CABLE and CABLE ASSEMBLY service, Whitaker also offers a quality line of standard cable products . . . Catalog on request . . . Your inquiries are solicited

Illustration above shows an example of one of many complicated jobs recently produced in volume by Whitaker

WHITAKER CABLE CORPORATION

General Offices: 1301 Burlington Avenue, Kansas City 16, Missouri
Factories: Kansas City, Mo. • St. Joseph, Mo. • Philadelphia • Oakland

IF YOUR PRODUCTION NEEDS include:
★ WIRING HARNESSES ★ CABLE ASSEMBLIES
★ BONDING JUMPERS ★ CABLE or TERMINALS
--you'll find WHITAKER
is a dependable source



On Clipper or Cub

EMYCEL TURNS SHOP TIME INTO FLYING TIME

For over four years EMYCEL has been setting service records on all types of planes the world over. Big or little they spend more time in the air—less in the hangar when they are protected by this superior fabric finish.

Time after time EMYCEL-finished fabric surfaces have been put through the toughest service tests under all kinds of climatic conditions—yet have been able to keep their strength and toutness without layoffs for refinishing. Write to Department 805 for portfolio of technical information. It contains the complete story of EMYCEL's properties and methods of application.

WHY EMYCEL IS MAKING FABRIC FINISHING HISTORY

EMYCEL is economical. Four or five coats do the job of eight to twelve coats of conventional material.

EMYCEL is faster. All-spray system cuts fabric-finishing time as much as 30%.

EMYCEL film is uniform. No thinners are used. Viscosity accurately determined and controlled at point of manufacture.

EMYCEL prolongs the life of fabric. Superior flexibility resists impact of flying stones and gravel. And Roxalin's patented fungicidal principle protects fabric against mildew.

EMYCEL can be applied in all kinds of weather. Moisture in the air will not cause blushing.

EMYCEL is C. A. A. approved.

ROXALIN Flexible FINISHES
INCORPORATED
ELIZABETH, F & N W JERSEY

U. S. Patent No. 2330000

WATCH ROXALIN IN AVIATION

RUST PREVENTION

A "must" in processing Government-owned production equipment for storage. Texaco rustproofing products meet Government specifications for this purpose.

HIGH on the list of reconversion "musts" is protection against ruinous RUST for machines, precision tools and other production equipment made idle by termination of war contracts. If the equipment is Government-owned, contract specifications require that it be cleaned and processed *with minimum delay* after production ceases. If it is your own equipment, full protection of your investment naturally calls for equally prompt rustproofing precautions.

Ordnance Specification P.S. 300-4 for processing, packaging, packing and marking of production equipment gives exact specifications for rustproofing materials that must be used on Government-owned equipment. Texaco rustproofing products meet Government specifications. They are easily applied through the medium of brush, dip or spray, and provide a protective coating that will assure preservation for years.

Whatever your rustproofing requirements, a Texaco representative can render helpful service. Get in touch with the nearest of the more than 2300 Texaco distributing points in the 48 States, or write to The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO Rustproofing Products

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS

METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

HOLLEY DEPENDABILITY BROADENS HORIZONS

On land, in the air and on the water, the dependable performance of Holley Carburetors broadens horizons and facilitates travel. At present, this dependability is contributing substantially to our war effort, and when peace comes again, this same dependable performance will add new values to many peacetime products. Where performance is paramount, the preference is for Holley.

HOLLEY

AIRCRAFT, AUTOMOTIVE, MARINE

CARBURETORS AND ACCESSORIES

COILFORMS OF NYLON

Used in U. S. Navy Sound-Powered Telephone Units

FOUND TOUGHER—LESS EXPENSIVE—MORE HEAT-RESISTANT

PAPER COILFORMS made of three layers of 0.004 inch gummed kraft paper, with vulcanized fiber flanges, anchored by fillet of phenolic cement.

NYLON COILFORMS Injection molded of Du Pont FM-1 nylon molding powder by Boonton Molding Co. Boonton, N. J., for Control Instrument Co., Bklyn., N.Y.

FOR PLASTICS, CONSULT DU PONT

ADVANTAGES—For maximum sensitivity and output in Navy sound-powered telephone units, many turns of wire must be placed as close to an armature as possible. Though the wall of the nylon core is only 0.012 inch thick, it maintains, under test, dimensional and dielectric stability at temperatures ranging from −60° F. to +400° F. According to the manufacturer, operations have been reduced from six to three, thus contributing to cutting the cost of the finished coilform by 50% with the use of nylon. With the old materials only about 10% yield was obtained, with nylon the average yield is better than 95%. With a two-cavity die, injection-molded nylon has increased coilform production per man 800 to 1000%.

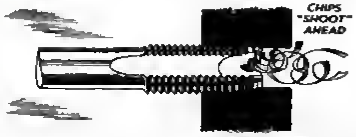
AVAILABILITY—The current supply of Du Pont nylon is available only for war applications and experimental work. For information write E. I. du Pont de Nemours & Company (Inc.), Plastics Department, Arlington, New Jersey.

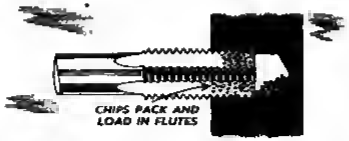
NEW TAP, [illegible]OPED FOR BOTT[illegible]OLES
[illegible]AL, SOLVES OLD P[illegible]
SHOW-HOW

1 On a routine call at an aircraft factory, "Greenfield" distributor's salesman was told—in casual way—that production could be speeded up on a certain job except for traditionally poor performance of ordinary bottoming taps in threading blind holes in stringy materials.

2 Conversation was repeated to "Greenfield Man" in that territory who in turn took it up with "Greenfield" engineers at home office. In spite of fact that this was an accepted limitation of ordinary bottoming taps, "Greenfield" research laboratory tackled this old problem again.

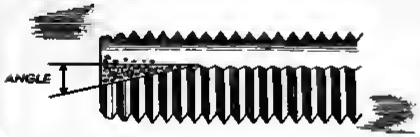
3 Experience showed that "Gun" tap with its clean shearing action was ideal for this material but that cutting angle which gives this shearing action shoots chips ahead of the tap, normally restricts use to through holes or blind holes with plenty of chip room at bottom.

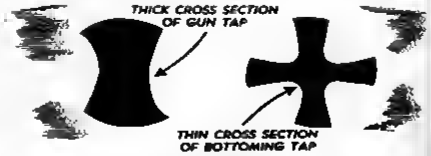




4 Action of ordinary bottoming taps tends to "load" chips in flutes, causing torn threads at bottom of holes when chips pack down, traditionally accepted as unavoidable. These taps are also somewhat more susceptible to breakage because of smaller cross-sectional metallic area than "Gun" taps.

5 "Greenfield" researchers working on theory that "Gun" shearing action combined with chip breaking action would solve this problem, finally developed a cutting angle on a bottoming "Gun" tap which gave desired result. Additional flute space at point of tap provided extra room for chip disposal.





6 New tap retained advantages of "Gun" tap's shearing cut and heavy cross-sectional metallic area for maximum strength, tap could cut full clean thread to bottom of hole. Tap breakage was reduced.

Results:

(1) Aircraft manufacturer tested new "Bottoming Gun Tap" could be used on screw machines putting whole operation of production basis for [illegible] New tap, tested on similar operations in plants of [illegible]ine and optical instrument manufacturers, gave satisfying results. "Greenfield" could SHOW HOW problem has been solved before . . . (3) A new and valuable tool was added to "Greenfield's" line.

"Greenfield's" SHOW-HOW is SHOW-HOW in action! PROBLEMS CAN TRUE "Greenfield" OUR "Greenfield"

BALANCE

Sensitive balancing ways are used to make certain of the accuracy of Abrasive Company Grinding Wheels.

Balance might be the one word to describe Abrasive Company excellence. Mechanical balance is essential for efficient grinding and is a "must" in every Borolon and Electrolon Grinding Wheel. Balance prevents vibration and chattering; and lengthens the life of valuable grinding machinery. Balance starts with selection of raw material, and the manufacture of abrasive grains. Hundreds of balanced formulas produce just the right bond for many combinations of grade and density. Balanced control of molding processes; balanced regulation of kiln heats and operation; balance in the finishing; and balance in tests and inspections are all basic to quality in Abrasive Company manufacturing.

Balanced inventories in factory stock and on distributors' shelves make Abrasive Electrolon and Borolon Grinding Wheels; Segments; Mounted Wheels and Points; Grains, Bricks, and Sticks available for your every specific abrasive requirement.

Company

Division of Simonds Saw and Steel Company

ABRASIVE COMPANY · TACONY AND FRALEY STREETS · PHILADELPHIA 37, PA.

AV-16

Announcing the New

ELECTRIC MOTOR VALVE

BY GENERAL CONTROLS

A new electric motor-operated, non-current failure shut-off valve, for fuel, hydraulic and lubricating oil systems. An exclusive design and development by General Controls.

Light Weight • Compact Size • Tight Shut-Off • High Flows
With Low Pressure Drop • Low Current Consumption

Equipped with explosion-proof motor and switch cover, standard Army-Navy or terminal type electrical connection. I.P.S., AN or AC tube and flange fluid connections ⅜" to 3" furnished. Engineering data will be furnished to authorized users upon request.

Phone, wire or write factory or contact your nearest factory branch office

hi-g
GENERAL CONTROLS
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SAN FRANCISCO • HOUSTON • *DISTRIBUTORS IN PRINCIPAL CITIES*

WEIGHT

BELL
DOUGLAS
NORTHROP
SIKORSKY
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RYAN
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MARTIN
CURTISS-WRIGHT

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CHANCE-VOUGHT
NORTH AMERICAN
GOODYEAR
FAIRCHILD
BOEING
REPUBLIC
CONSOLIDATED

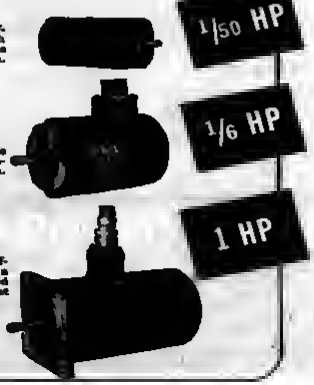
Aeronautical weight engineers, evaluating the savings in dollars and cents resulting from the elimination of each pound of weight in airplanes have computed this value at an average of $135.00 per pound per airplane per year. In military planes each pound saved means more maneuverability, speed and efficiency. The principles of weight engineering have always been one of the dominant factors in Warren McArthur research, design, engineering and manufacturing.

WARREN McARTHUR CORPORATION

ONE PARK AVENUE NEW YORK CITY

WIDE RANGE OF WESTINGHOUSE *LONGER LIFE* AIRCRAFT MOTORS

Westinghouse pioneered in the development of aircraft motors . . . in research, design; engineering. Using the finest materials and manufacturing methods, Westinghouse Aircraft Motors have kept pace with aeronautical progress. They are light in weight and small in proportion to their ratings. A wide variety of sizes and ratings are available to meet individual requirements.



This open-type, self-ventilated motor, with 2½" frame, provides 1/50 hp at 4800 rpm.

This aircraft motor is rated at 1/6 hp continuously at 5800 rpm.

This open-type, self-ventilated motor has a 4" frame and is rated 1 hp continuously at 7500 rpm.

In the stra[illegible] as 50,000 feet—aircraft motors must withstand extremes of temperature, [illegible] pressure, humidity. These unearthly conditions required development of aircraft motors that gave dependable performance . . . from "take-off" in tropical jungle heat . . . to "ceiling" flying in sub-zero, rarefied air.

Westinghouse Aircraft Motors have been designed and built to meet these severe requirements. Westinghouse research engineers check and analyze the performance of motors, brushes and commutators in a high altitude chamber which duplicates conditions at 50,000 feet. Temperature is lowered to minus 67° F. to check starting conditions . . . atmospheric pressures of 1/7 sea-level pressure show the motors' performance when starved for ventilation.

Aircraft requirements of light, durable, compact, rugged construction . . . are met in Westinghouse Aircraft Motors. Their dependable performance has been proved on many types of planes—from the largest bombers to the smallest fighters. For complete information on Westinghouse Aircraft Motors call your nearest Westinghouse office. Or, write Westinghouse Electric & Manufacturing Company, Lima, Ohio.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

AIRCRAFT MOTORS

for

AIRCRAFT CONTROLS

Identified with the aircraft industry from its earliest days, NORMA-HOFFMANN pioneered many of tha important bearing types now accepted as standard in aviation practice. * * * * Today, almost every representative builder of aircraft, engines, instruments, and equipmant—including tha United States Government—employs NORMA-HOFFMANN PRECISION BEARINGS to insure safety and long, uninterrupted service. * * * * Typical NORMA-HOFFMANN Aircraft Bearings are here illustrated. Write for the general Engineering Catalog which describes 108 distinct series embracing over 3000 sizes—a PRECISION BEARING for every load, speed and duty.

ORMA-HOFFMANN BEARINGS CORPORATION STAMFORD, CONN U S A

PRECISION BALL, ROLLER AND THRUST BEARINGS

ANNOUNCING

DISTRIBUTORS FOR

DC 993 VARNISH

Essential to High Temperature Silicone Insulation

Rapidly growing demands for DC-993 Silicone Varnish are being filled from stocks of the above newly-appointed distributors.

Through these representative sources of supply, Dow Corning, first producer of Silicones, is able to extend the application of this revolutionary insulating material—a heat curing, high temperature stable, moisture-proof silicone varnish destined for an important place in the new age of electrical machinery and equipment.

DOW CORNING CORPORATION
BOX 592, MIDLAND, MICHIGAN

JUST OFF THE PRESS—This new eight-page book on DC-993 Silicone Varnish is now available from any of the distributors listed above. Write for a copy. It will give you comprehensive technical information on this new insulating material and its applications.

DC

An airplane's flight depends upon the unfailing teamwork of thousands of parts.

Consider an American Bosch Aviation magneto which produces the vital life spark of an engine. Take just one of its precision parts — the all-important coil. It contains nearly 1¾ miles of thread-thin copper wire.

Almost literally, the airplane hangs by that "thread."

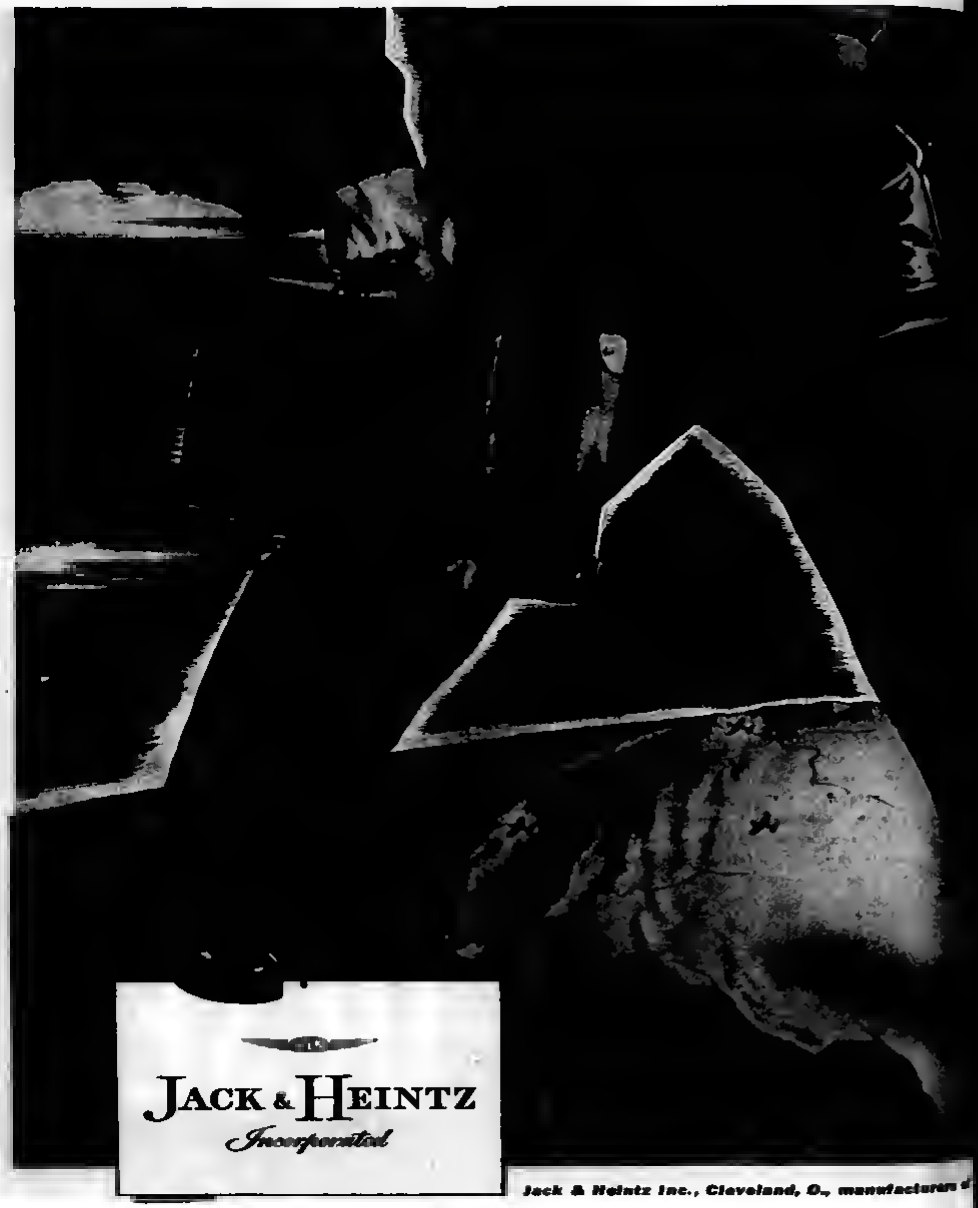
Important as that wire is, it is only one of the precision parts which gives the American Bosch magneto its unfailing performance and dependability.

The magneto is just another product of American Bosch precision production for power — the result of engineering leadership and craftsmanship in the New England tradition.

This know-how is what attracts so many American engine builders to Springfield for solution of their ignition, fuel injection and related problems.

AMERICAN BOSCH CORPORATION • *Springfield 7, Massachusetts*

AMERICAN BOSCH
PRECISION PRODUCTION FOR POWER



SERVICE
in Seven League Boots

BORDER to border—coast to coast—wherever skilled technical service may be needed, Jack & Heintz can be on the job in 24 hours! Not satisfied with mass producing precision aircraft equipment for war, we have built up a corps of trained field experts to help with its installation and maintenance.

Since Pearl Harbor, this group of nearly a hundred specialists has done yeoman duty in keeping 'em flying for victory. Because idle planes are as profitless in peace as they are useless in war, these men can be a tremendous asset to post-war commercial aviation.

Remember, in future planning, that all Jack & Heintz products—instruments, starters, motors, generators, magnetos—are backed by nationwide service . . . in seven-league boots!

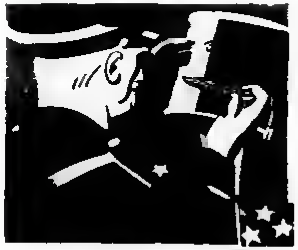
JACK & HEINTZ
Incorporated

Jack & Heintz Inc., Cleveland, O., manufacturers of aircraft engine starters, generators, gyro pilots, gyro flight instruments, magnetos, motors.

1 Atmospheric temperature changes cause water to condense or "sweat" on metal surfaces in large amounts.

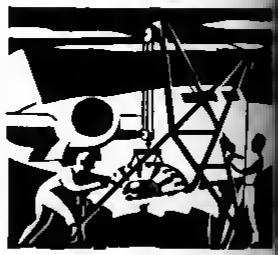
2 This sweating goes on *inside* engines. And the naked metal of cylinder walls, piston surfaces, etc., will quickly corrode under its attacks.

3 Of course, this isn't a problem while engines are used. But when they are to be stored or shipped overseas, internal waterproofing is essential.



4 One of the first and most successful answers to Army Air Force requests for a product to meet this problem was STOP RUST B.

5 STOP RUST B is a lubricant which forms a non-drying, non-hardening film. Even the smallest surfaces are completely sealed against rust.



6 Engines with STOP RUST B in them may be placed in service without special cleaning or servicing, for STOP RUST B is harmless to metal or fuels.

As an additional service, STOP RUST B contains a special ingredient to neutralize any acid residues left in the engine from fuel combustion. Its detergent properties help to reduce sludge formation. STOP RUST B meets specification AN-VV-C-576a and is used in accordance with standard instructions governing processing of aircraft engines. It can be used on equipment of any make or model, including ground engines. Phone your local Union Oil Company representative for a supply of STOP RUST B, the *internal* rust preventive...or write Union Oil Company, 617 W. 7th, Los Angeles 14, Cal.

STOP RUST B

UNION 76

Another UNION OIL *Success-Tested Product*

HERE'S HOW EASY IT IS TO OPERATE

Push-tite COUPLINGS

Hansen PUSH-TITE Couplings are simplicity personified, not only in design, but in handling and in operation. They are quicker and easier to connect and disconnect, are fool-proof, leak-proof, compact and sturdy. Handle pressures from 2 ounces to over 12,000 pounds.

Hansen PUSH-TITE couplings have earned their world-wide popularity on performance, saving time, effort and costly air. There's a Hansen coupling made to handle air, oil, grease, oxygen, acetylene and gasoline.

Send for free industrial catalog.

HANSEN MFG. CO.

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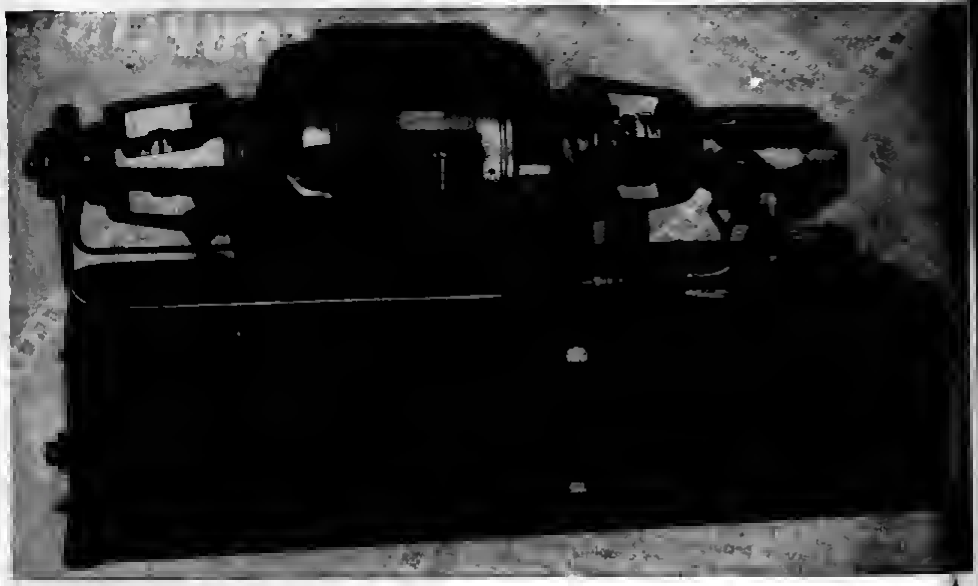
HYCON

Announcing Hi-Lo Hydraulic Power Units

Packaged Units for Fast Prefill
with 3000 p. s. i. Closing and Holding Pressure

Using 10 GPM and 20 GPM Low Pressure Pumps
in Combination with ¾ GPM and 1½ GPM Pumps at 3000 p. s. i.

Units Complete with Pumps on Double End Motor . . . Unloading and Relief Valves
and Micronic Filter . . . All Mounted on 40 Gal. Water Cooled Reservoir



Specifications and Engineering Data on Request

THE NEW YORK AIR BRAKE COMPANY
Hydraulic Division

460 LEXINGTON AVENUE, NEW YORK 17, N. Y. • FACTORIES: WATERTOWN, N. Y.

Year Round Service *over the* North Atlantic

Over a 2000 mile North Atlantic route that often becomes 3000 miles against 90 knot headwinds, British Overseas Airways Corporation maintains year-round scheduled service on a trail blazed through some of the worst weather that ever beset an airline.

Heavily-loaded takeoffs, fast climbs to surmount treacherous icing conditions, and high-altitude cruising at sub-zero temperatures are among the requirements met by modified Liberators equipped with Curtiss Propellers.

This achievement is outstanding among the many transoceanic schedules now being maintained in all parts of the world by Curtiss equipped aircraft—forerunners of giant craft in which world travelers will find Curtiss automatic synchronizers and aerodynamic braking providing a new level of passenger comfort.

CURTISS
ELECTRIC PROPELLERS

Curtiss-Wright Corporation, Propeller Division

BREEZE MARK

1. Inner flexible conduit affords maximum physical protection to wiring.
2. Braided wire covering, sometimes in multiple layers, improves the electrical shielding and provides increased ruggedness.
3. Main conduit manifold is bent to shape from seamless tubing

Electrically Sealed Circuits

WITH BREEZE RADIO IGNITION SHIELDING

The Breeze Radio Ignition Shielding which equips the modern aircraft engine is the product of extensive laboratory test and research.

Effective shielding calls for a metal case of high conductivity around possible sources of radio interference, designed to lead off high frequency impulses to the ground and prevent their radiation. Each installation must be custom engineered to meet the needs of the problems involved.

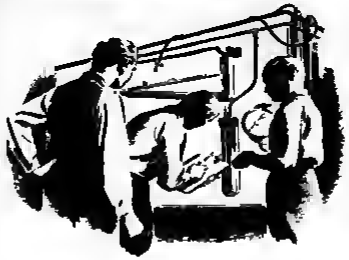
Breeze Shielding is designed for ruggedness, resistance to vibration, and maximum isolation of high frequency interference. Each wire of the braided cover must be positively soldered at each connection, inner conduit must be tight to avoid electrical leakage, and fittings must be precision-machined for close fit and uniform pressure of contact faces.

New shielding problems presented by the rapid advance in the science of radio communication and television are constantly being solved by Breeze engineering. A background of many years experience in shielding automotive, aircraft, marine and commercial engines has made Breeze America's headquarters for Radio Ignition Shielding.

Breeze CORPORATIONS, INC.
Newark, New Jersey

A preview of Peacetime Flight

The C-97 Boeing cargo plane that crossed the continent in six hours forecasts a new kind of air travel. For this plane will be known as the "Boeing Stratocruiser" in a commercial postwar model, flying its faster, smoother course in the sub-stratosphere. Pressurized cabins make such flight possible—AiResearch's job has been to develop the cabin-pressure controls.



First, "weather" had to be *created*: air conditions in all parts of the globe and thousands of feet above it were manufactured to order. Then, in temperatures as low as minus 90° F, the reactions of crew and equipment could be studied through each step of engineering the controls.

Next, countless hours in the "Stratolab"—the giant vacuum chamber built for research on high-altitude flying. Here, in pressures as low as those found at 65,000 feet above sea level, the problems of comfort-protecting airplane cabins during substratosphere flight were solved.

Yes, there's a new kind of air travel coming! And AiResearch is helping to create it *now* with research, engineering and precision manufacture. AiResearch Manufacturing Company, Los Angeles and Phoenix.

"Where *Controlled Air Does the Job*" Automatic Exit Flap Control Systems • Temperature Control Systems • Engine Air Intercooling Systems • Cabin Pressure Regulating Systems • Supercharger Aftercooling Systems • Engine Oil Cooling Systems

AiResearch
DIVISION OF
THE GARRETT CORPORATION

Retractable-ailerons . . . a Northrop contribution to slow landings . . . "hoverability" short take-offs . . . tight, fast turns

As long as ailerons took up space that could be used by longer flaps, stalling speeds were higher than they needed to be, landing speeds were excessive, and air strips too long and costly.

Now, there's an aileron which *frees* that vital space on the wing's trailing edge. It's the Northrop *Retractable-Aileron*—operating upward and out of the wing, well in front of the full-span flap.

This new and more efficient type aileron is the biggest single reason the Northrop Black Widow, despite its heftiness and speed, handles so easily . . . why it's such an "honest," reliable airplane.

Retractable-ailerons and full-span flaps are but two of many advanced features on the Black Widow —features that have made this huge night-fighter more maneuverable, made it the master of the best Axis pursuits.

In peacetime, this Northrop achievement will contribute added safety and comfort through reduced landing and take-off speeds in passenger carrying planes. And in airports of the future it can mean a more economical use of landing strip space. Northrop Aircraft, Inc., Northrop Field, Hawthorne, Calif. Member Aircraft War Production Council, Inc.

NORTHROP *Creators of the* ***Flying Wing*** *and the* ***Black Widow*** *P-61 Night Fighter*

To meet higher production schedules on warplanes, the aircraft industry should have more fabricators to make magnesium assemblies—doors, tanks, control surfaces. Plants all over the country can help produce the many items required.

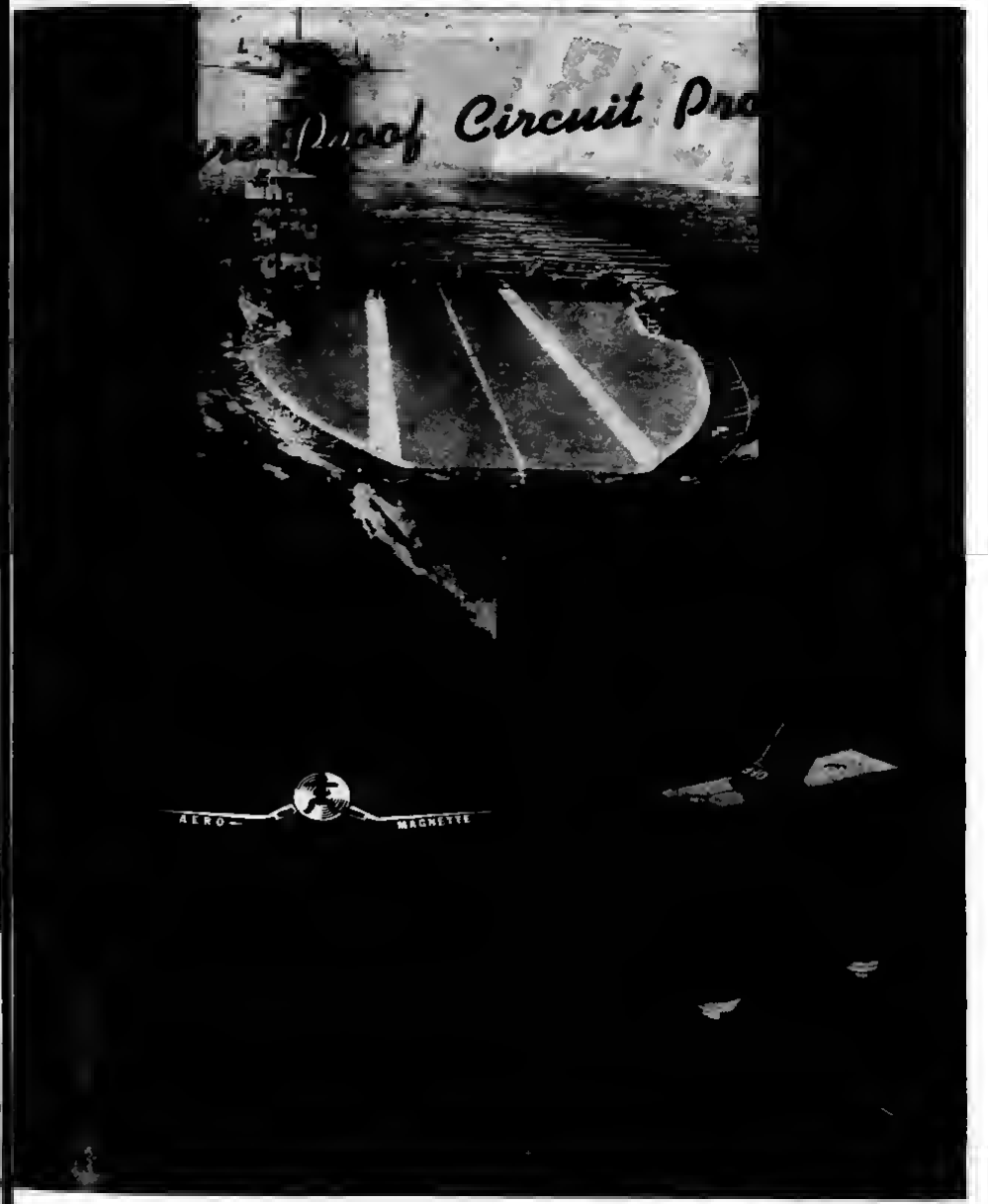
Perhaps you have the equipment and the manpower to make these magnesium plane parts. Don't hesitate about tackling these jobs because you have had little or no experience with magnesium. Our twenty-five years' experience in magnesium fabrication is at your service.

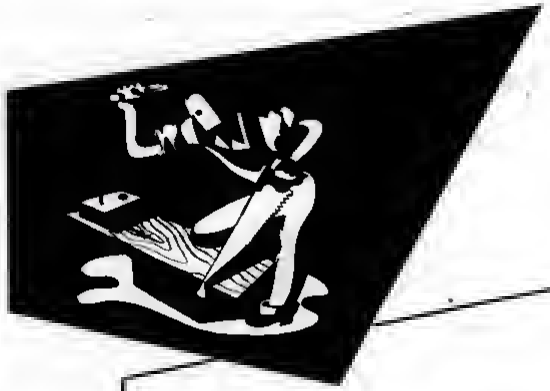
Equipping your plant for hot forming magnesium is not difficult. Call on us for any assistance you may need on fabricating procedures. We'll gladly help you. Aluminum Company of America, Sales Agent for American Magnesium products, 1713 Gulf Building, Pittsburgh 19, Pennsylvania.

MAGNESIUM MAZLO PRODUCTS

AMERICAN [illegible] CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA





Ambidextrous

THERE's as much similarity between oil and water as there is between Electronics and Hydraulics. ■ But we're ambidextrous . . . *we work with both.* In separate plants. With different staffs. And good, they tell us. They? Airlines, aircraft manufacturers, the armed services. ■ We did a fair volume for these folks before the war. Doing a whopping volume now. Don't expect to keep whopping after the war. But we're prepared to wager that aviation is here to stay, and that we'll have what it wants in precision-engineered hydraulic and electronic equipment. ■ Your engineers and ours should get together. Our factories can translate their conversation into the devices and service you want.

Aireon MANUFACTURING CORPORATION

Formerly *AIRCRAFT ACCESSORIES CORPORATION*

Radio and Electronics • Engineered Power Controls

NEW YORK • • CHICAGO • • KANSAS CITY • • BURBANK

THE FACTS ABOUT SMALL METAL TUBING UP TO 5/8" OD

Superior facilities are devoted exclusively to the production of small metal tubing. Long before the war we set our maximum size at ⅝" OD because experience has shown that only by so doing could we maintain high quality in the smaller diameters. As a result, we have a mill, operating at top speed, equipped to produce in a routine manner what formerly was known as "specialty" tubing. So, if you need cold drawn tubing in any metal, and the OD does not exceed ⅝"— then the inherent benefits of our specialization are yours for the using.

SUPERIOR

THE BIG NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

ARMY NAVY

FOR EVERY SMALL TUBING APPLICATION FROM ⅝" OD DOWN

SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless, "Monel" and "Inconel".

SEAMLESS and Patented LOCKSEAM Cathode Sleeves

Special Motor Application . . . *Improves Machine Performance . . . Meets Mechanical Specifications.* Although standard off-the-shelf motors can often be used in a product, experience proves that when the electric motor is specially designed for a specific application, the machine operates better, more economically with less maintenance.

For over 50 years Holtzer-Cabot has concentrated its facilities in the design and application of special motors, such as those illustrated above, to meet specific design and performance requirements of such products as machine tools, instruments, business machines and aircraft. And although today, military requirements get first call on all of Holtzer-Cabot's motor production, our motor development engineers will gladly discuss your postwar fractional H P motor requirements with you. There is no obligation, of course

HOLTZER-CABOT

Division of First Industrial Corporation

Designers and Builders of Special Fractional HP Motors and Electrical Apparatus

125 AMORY STREET, BOSTON 19, MASS. • NEW YORK, N. Y. • CHICAGO, ILL. • PHILADELPHIA, PA.

AIRCRAFT HOSE ASSEMBLIES

must:

1. Remain pressure-tight under severe vibration and flexing.
2. Resist the action of oil and gasoline both inside and out.
3. Withstand temperature ranges specified by the Air Corps.
4. Resist the action of cleaning fluid externally.
5. Withstand the abrasion of flying pebbles and sand.
6. Be as light as possible consistent with the bursting strength required.

The continued research by Flex-O-Tube engineers over a number of years has been an important factor in the present high state of development of aircraft hose assemblies.

Consult

FLEX-O-TUBE

on any hose assembly application, especially on postwar products.

Flex-O-Tube

LAFAYETTE at 14th AVE.
DETROIT 16 MICHIGAN
Offices: CHICAGO FORT WORTH
LOS ANGELES NEW YORK
SEATTLE · TORONTO, ONT.

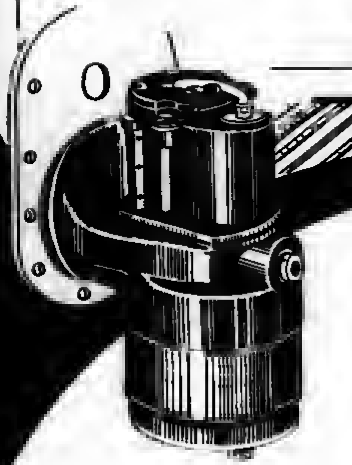
WATCH

for the April Announcement of

A *Fully Submerged*

WATER INJECTION PUMP

by Romec



You have a surprise coming in uur April announcement. True to ROMEC tradition, we will annuunce another ROMEC *First*. That will be a fully submerged Water Injectiun Pump. A year agu, this was merely an aim. Now it becomes a reality.

ROMEC precision aircraft pumps pioneered in the first "round the world" flights, pioneered the non-pulsating rotor principle, high attitude booster pumps, hydrauiic pumps, and thu solutiun to corrosion in water injection systems. Write today if you want us to mail you a copy of the April announcement on thu fully submerged ROMEC Water Injection Pump.

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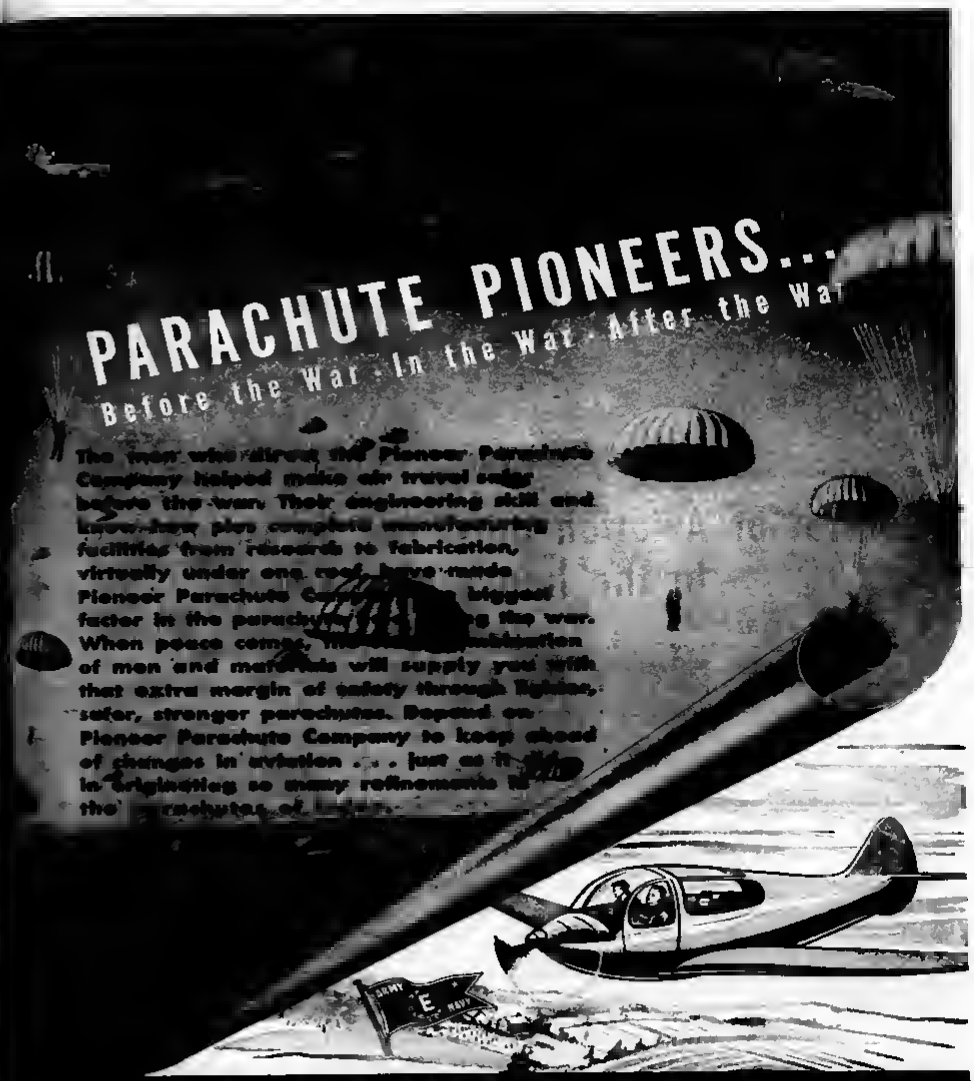
Before the War · In the War · After the War

The men who started the Pioneer Parachute Company helped make air travel safe before the war. Their engineering skill and know-how plus complete manufacturing facilities from research to fabrication, virtually under one roof, have made Pioneer Parachute Co[illegible] biggest factor in the parachute [illegible] the war. When peace comes, [illegible] distribution of men and materials will supply you with that extra margin of safety through lighter, safer, stronger parachutes. Depend on Pioneer Parachute Company to keep ahead of changes in aviation . . . just as it is originating so many refinements in the [illegible] parachutes of [illegible]



PIONEER PARACHUTE COMPANY, INC.

MANCHESTER, CONNECTICUT, U. S. A.

WEST COAST FACTOEY EEANCH, 109 SOUTH CENTRAL AVENUE, GLENDALE 4, CALIFORNIA

"Control of Aviation must not be concentrated in the hands of a few!"

says CARLETON PUTNAM, President of Chicago and Southern Air Lines
Member United States Delegation (Advisor), International Civil Aviation Conference

"EVERYONE WONDERS what changes the Air Age will bring. The airplane is revolutionary. Travel by water has been slow. Travel by rail and highway has been comfortable. But travel by air is direct and has made even remote places accessible. So, we sense in the airplane an instrument of extraordinary power to change our way of life.

"If we are to obtain maximum social benefits from the Air Age, the development of flying must not be stifled either domestically or internationally by restrictive government policies.

And control of aviation must not be concentrated in the hands of a few. We must make sure that a regulated but well diffused enterprise be allowed to breathe in its dynamic spirit into this industry now. Only then can we transport provide the largest field of endeavor to flying pioneers and make its full contribution to mankind."

Yes, Mr. Putnam, the air age will bring many changes, but before the air age revolutionizes the way we live in the U. S. A., aviation must be sold on the whole nation. And the first group to sell is this country is the "best pilots" market—the people who, in business or in private flying, are habitually first to accept any change for the better.

This is the market aviation thinks of when it thinks of the more than a million TIME-reading families who are America's best prospects for planes and air travel—whose position in American business makes them the natural vanguard for any program aviation may set up.

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For Utmost Dependability... WITTEK Aviation HOSE CLAMPS

Dependability has been recognized by Wittek Manufacturing Company during 25 years of hose clamp manufacturing experience as a foremost requirement in hose clamp design. Wittek assures this dependability by the selection of the sound design — the use of high materials and the application of workmanship. Today Wittek manufactures distinctly different hose clamp [illegible] each of which meet the requirements [illegible] specification AN-H-C-516a.

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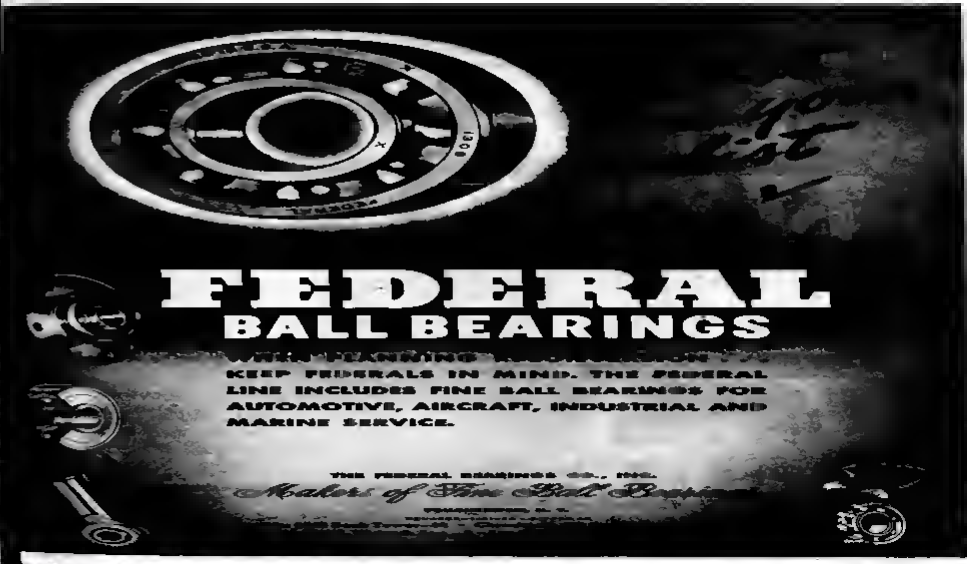
Hose Clamps for all requirements [illegible] by Wittek—specialists in hose clamps [illegible] their applications.

TEK ING CO. Chicago 32, Ill

Aviation HOSE CLAMPS



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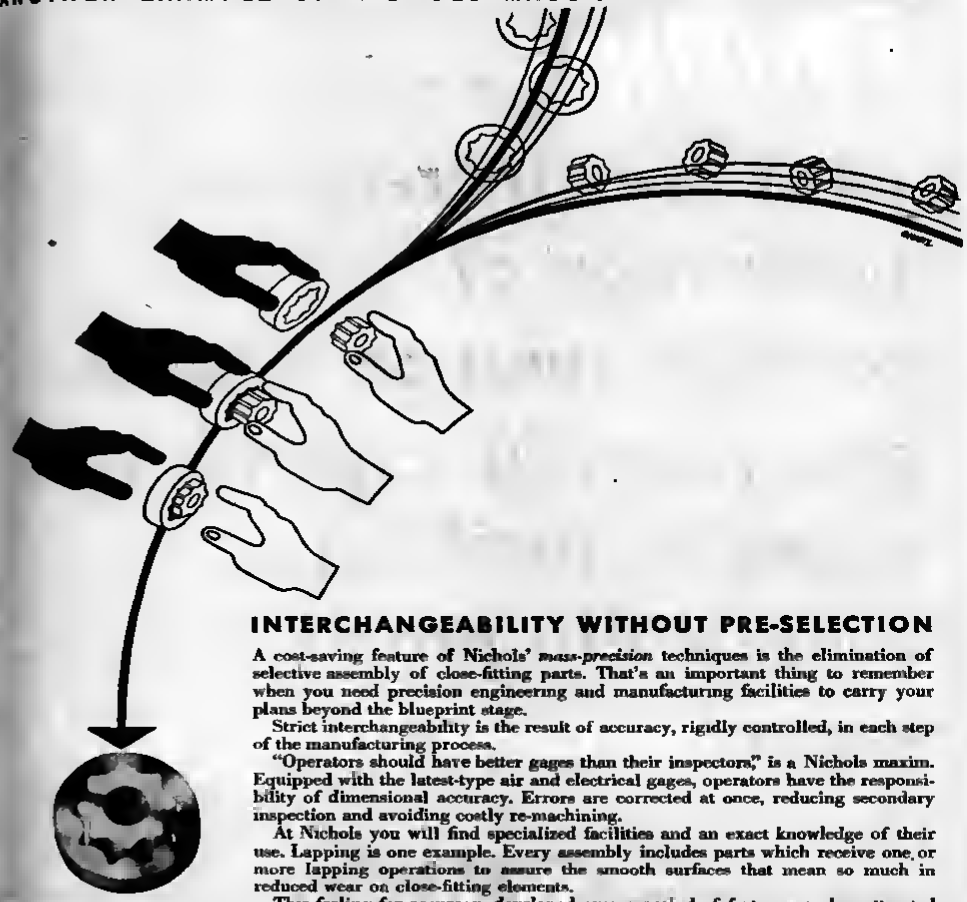
THIRTY-FIVE YEARS AGO, The Leece-Neville Company was founded to manufacture the best heavy duty electrical equipment possible. To this day, Leece-Neville has never veered from that course. This steadfast specialization, this concentration of research, engineering and manufacturing facilities means only one thing to members of the aircraft industry. Today, you can use Leece-Neville electrical equipment with the assurance that it is the finest and most advanced available anywhere. *Anywhere in the world!*

THE LEECE-NEVILLE COMPANY
CLEVELAND OHIO

Pioneer and still Quality Leader in heavy duty electrical equipment

ANOTHER EXAMPLE OF NICHOLS MASS-PRECISION METHODS



INTERCHANGEABILITY WITHOUT PRE-SELECTION

A cost-saving feature of Nichols' *mass-precision* techniques is the elimination of selective assembly of close-fitting parts. That's an important thing to remember when you need precision engineering and manufacturing facilities to carry your plans beyond the blueprint stage.

Strict interchangeability is the result of accuracy, rigidly controlled, in each step of the manufacturing process.

"Operators should have better gages than their inspectors," is a Nichols maxim. Equipped with the latest-type air and electrical gages, operators have the responsibility of dimensional accuracy. Errors are corrected at once, reducing secondary inspection and avoiding costly re-machining.

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This feeling for accuracy, developed over a period of forty years, has attracted the unusual precision problems to Nichols for successful development and economical mass-production.

Nichols-built products have been called "the most accurate assembly of commercial parts ever produced." The case-histories of these products are discussed in "Mass-Precision," our new brochure. It will prove helpful when you are faced with a similar "hard-to-make" part or assembly. May we send you a copy?

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"Accurate" *Nichols*

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

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We build SUPER SHIMMY DAMPERS *for Superfortresses*

● One of World War II's greatest engineering and manufacturing epics unquestionably is the Boeing B-29 Superfortress.

It carries a heavier bomb load, farther, faster and higher than any tbe world has ever known. Yet it handles more easily than many planes much smaller.

All-important to safe, true landings and take-offs of this giant aircraft is its huge dual nosewheel. For it . . . to prevent shimmying . . . Houdaille* developed a special Hydraolic Shimmy Damper. It is, in truth, a Super Shimmy Damper, for it is capable of cootrolling forces of far greater magnitude thao any previously encountered in Hoodaille's aviation experienee.

Houdaille is prepared to design still bigger units if the need arises.

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MAKERS OF HYDRAULIC CONTEOLS
Buffalo 11, New York

*Pronounced—How-dye

MANUFACTURERS OF PRECISION PARTS AND EQUIPMENT FOR THE AUTOMOTIVE . . . AIRCRAFT . . . RAILWAY . . . MARITIME . . . ELECTRIC REFRIGERATION . . . RADIO AND OTHER INDUSTRY

YARDSTICK *for Fledglings . . . . .*

Come V-J day, hundreds of thousands of fledglings are going to get into the sky—for business and for fun. Whether they fly their own, or an operator's plane, they'll want to know—

Is the engine: **DEPENDABLE . . . ECONOMICAL . . . POWERFUL . . . RUGGED . . . SERVICEABLE . . .**

Apply these yardsticks to Kinner—look at the Kinner record.

Kinner for a quarter century has built dependable, economical engines that have given millions of hours of trouble-free flying to owners and operators. Thousands of today's "hot" fighter and bomber pilots got their first training behind Kinners. Kinners have ample reserve power for take-off and emergency; they are rugged—built to stand up to punishment. And, Kinners are designed for easy servicing and checking. Kinner parts and service are *always* available; no Kinner has ever been "orphaned." Specify Kinner in the plane you fly—come V-J day.

KINNER MOTORS, INC., GLENDALE 4, CALIFORNIA

BUY WAR BONDS

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● *Built by*
PRATT & WHITNEY

Prelude to a dog fight!

A squadron of these Double Wasps means a squadron of vicious fighters sweeping the skies clear of enemy planes. And as each of these engines is hoisted into the nose of a fighting plane, so are SKF Bearings on its vital parts. As the plane takes off and attacks at speeds of more than 400 m.p.h., the use of SKF's becomes apparent. Then, as never before, the safety, dependability and all-round good performance of SKF Bearings *count*. When an SKF flies, you can depend upon it . . always

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Yours FOR BETTER ENGINE PERFORMANCE

The accurate measure of aircraft spark plugs is their ability to yield better performance, greater dependahility and longer life. Champion-Ceramic Aircraft Spark Plugs have compiled an unequalled record and are continuing to fill an unremitting demand from our air forces, air line operstors, and private pilots. All Champinn-Ceramic Aircraft Spark Plugs are products of the same materials, design and workmanship and, accordingly, provide that extra measure of performance, dependability and lnng life *in every aircraft engine* that has made them first choice for military, commercial and private planes. Use Champinns and fly with confidence. Champion Spark Plug Company, Tnledn 1, Ohin.

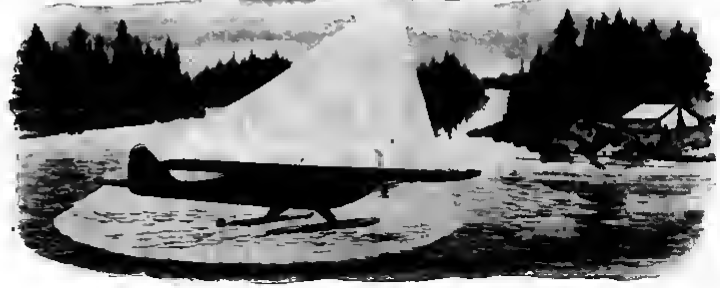
C26—Unshielded

DEPENDABLE

CHAMPION SPARK PLUGS

FOR EVERY AIRCRAFT ENGINE

C45—Shielded



Prepared for key engineering personnel of America's aircraft industry

OUR participation in the growth of [illegible] aircraft industry is of such a wide (and [illegible] times obscure) nature that this manual has been [illegible] pared to provide a catalog of materials and parts [illegible] ready engineering reference.

Main subjects covered comprise—Aircraft [illegible] Cables; Cold Rolled Strip Steel; U-S-S S[illegible] Steel; Wire—stitching, spring, and special wire [illegible] aircraft construction and maintenance; Cold [illegible] ished Steel Bars and Springs.

Included are comprehensive data covering [illegible] engineering of these various products, which we [illegible] will be helpful to the engineer in better [illegible] ing the uses to which our products may be put, [illegible] the problems involved in their application.

For information beyond that covered on [illegible] pages, the assistance of our many offices and [illegible] tories is at your service.

Because of restrictions imposed by war [illegible] we are unable to offer this manual for general [illegible] tribution, but if you are a chief engineer, project [illegible] neer, superintendent in charge of engi[illegible] or [illegible] similar executive office in the aviation [illegible] copy will be sent you upon request on your [illegible] letterhead. Copies are also available for library [illegible] aircraft manufacturing companies.

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York

COLUMBIA STEEL COMPANY
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Lighter pull...greater leverage

Because of a specially designed pulley, greater leverage with lighter pull has been attained in this new Interstate Gun Charger—selected by Douglas for the A-26 Invader.

In sky-combat on all fighting fronts, Interstate Gun Chargers of this same basic type have been widely and effectively used. Simple in design and operation; no parts to adjust; small, compact, light weight, yet it stands the gaff!

For detailed information about this and other Interstate Precision Units, address Sales Department, Interstate Aircraft and Engineering Corporation, El Segundo, California.

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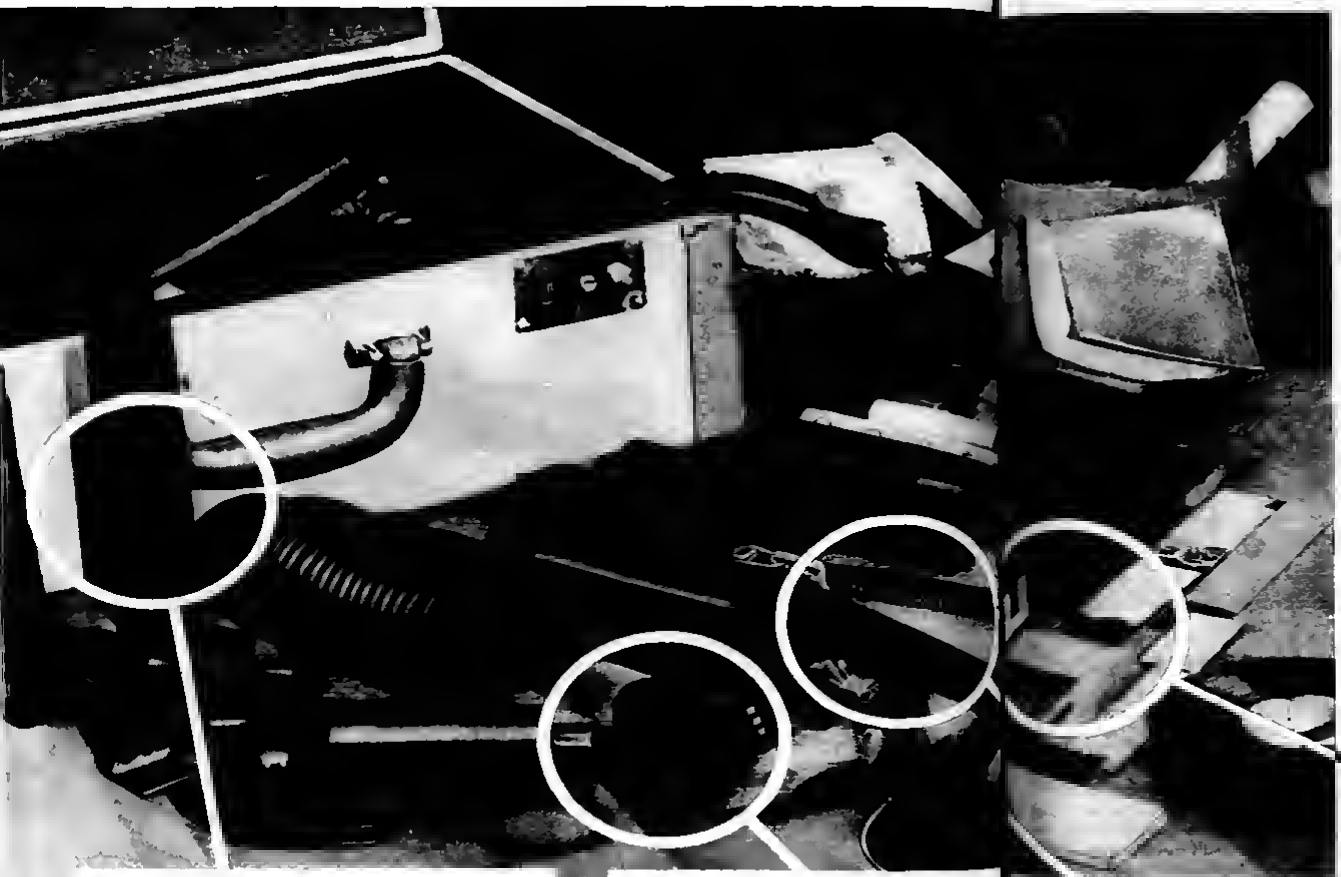
We'd like to show yo bag of new tricks...



You'll find it full of surprises . . . new materials, techniques, and skills you moy be able to use

HERE'S A DEMONSTRATION that ends with a pile of almost everytbing on the table. It's an assortment of unusual B. F. Goodrich materials and products, most of which are new to the aviation industry.

Included are sealing materials, molded parts, brightly colored fabrics and many others. Typical examples are described below.

B. F. Goodrich wants to find out if the aviation industry can use these products. So they're pulled out of the bag, described briefly, and tossed on the table to he handled, bent, stretched, or bounced.

Tbis demonstration is a great conversation-starter. Invariably new uses for materials will come out of it. And the audience discover B. F. Goodrich can do things with rubber they never thought possible.

Chances are, you and your associates can profit by this demonstration. We'll be glad to make it at your convenience. For a date, just write to The B. F. Goodrich Company, Aeronautical Division, Dept. A-3, Akron, Ohio.

All made by B.F. Goodrich

Tires • De-icers • anti-icing propeller sheaa • hydraulic hose and line [illegible]ssories• molded parts • [illegible]ts • fuel hose • oil seals [illegible]d over 80 rubber and [illegible] rubber airplane prod[illegible]

Skyway or Highway

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FIRST IN RUBBER

EVER SEE RUBBER-PLATED STEEL?

Here's a piece—solidly coated with rubber—done by the patented Anode process. Any steel part can be similarly treated if you have need for it.

FLEXLOCK COUPLING SEALS AIRPLANE PLUMBING LINES

Effective as seal or flexible joint. Ideal for use wherever vibration is a problem. Leakproof, installs in seconds. You'll be hearing more about this one.

ZIPPER SEALS LIQUIDS, GASES UNDER PRESSURE

Unique arrangement of overlapping rubber lips makes leakproof seal. Used as aileron gap seals, as closure for exposure suits, moisture-proof bags.

METAL-TO-METAL CEMENT . . . STRONGER THAN A WELD

This is called B.F. Goodrich Plastilock. With it you can join two pieces of metal with a minimum of cemented surface, and break the metal before you break the bond.

AMERICA WANTS COMPETITION

Only American Initiative Can Preserve It in World Trade

AMERICANS generally agree upon what constitutes a desirable pattern of international economic relationships. We want an expanding world trade, with minimum recourse to government-imposed trade barriers and discriminatory trading arrangements, and offering ample scope for competitive private enterprise. Because they are necessary to such trade, we want also stability of exchange rates, and national currencies that are mutually convertible at least for the settlement of current accounts. We want, too, arrangements to facilitate long-term capital loans with security to the lender and advantage to the borrower.

Few other nations subscribe to these aims with enthusiastic conviction. Some reject them flatly as impractical under the conditions likely to prevail during the postwar period, or achievable only at prohibitive cost to their domestic economies.

Unless, therefore, we can formulate a practical and comprehensive program to carry out our aims, and convince other nations that we will take a sustained and responsible part in making it effective, the international sale of the world surely will be conducted under a system of exchange controls, bilateral agreements, cartel arrangements, import quotas, and direct government purchasing arrangements that are the very antithesis of the competitive system that we favor.

To agree upon a concrete American program, and to convince other nations that it is to their advantage as well as ours to accept it, is a major task of economic statesmanship. It entails reversing a trend which has persisted since World War I, and which has been intensified during the depression years of the nineteen-thirties and by the exigencies of World War II.

Clearly, that is not a task to be assumed lightly. We can hope to be successful only if (1) we have a deep conviction that what we seek is fundamentally important to the American interest, and (2) if we will take pains to understand why other nations fear that such a program may jeopardize their interests, and then make whatever accommodations may be necessary to resolve their doubts.

An expansive foreign trade policy has been advocated very vigorously and repeatedly in America recently that the Economist (of London) comments wryly upon what it terms the ironic circumstance that "the acceptance of the principles of free trade by the more literate (American) public should come at a time when the doctrines in their simplest nineteenth-century form have been pretty generally emasculated in fact and repudiated in principle by the rest of the world".

☆ ☆ ☆

Why are we opposed to managed world trade, and for competitive world trade?

First, we are against rigged and managed international markets because we know that successful participation necessitates a comparable degree of control over the domestic economy as well. There is little debate of this fact, and those nations which accept a managed external trade as a necessary protective measure are generally willing to pay the price in internal regimentation. We are not. For us to do that would be as alien to our genius as it is repugnant to our conviction.

Second, we believe that the United States will be able to compete successfully in world markets, even though we have, and intend to maintain, wage scales far higher than those of the nations whose competition we must meet.

There is impressive evidence to substantiate the soundness of this conviction:

1. Wage scales, of themselves, do not determine the competitive position. They are meaningful only when translated into labor costs, by dividing wage rates by units produced. **A recent War Production Board study shows that in manufacturing industries generally, during the period immediately before the present war, production per man hour in the United States exceeded that in the United Kingdom, Germany and Soviet Russia by a ratio of more than 2½ to 1, and that of Japan by more than 4 to 1.** When comparison is made with available wage data, it appears that our labor costs are generally on a competitive plane.

2. Perhaps the best evidence of our ability to compete in export markets is the record of our demonstrated capacity to do so in the past. **During the entire period between World Wars I and II, the United States consistently commanded a greater share of the world's export trade than any other nation,** although the United Kingdom took a larger percentage of world imports.

3. We have been particularly successful in world trade competition in the export of machinery, vehicles, a variety of manufactured specialties, and certain agricultural products. Except in the last-named field, there is every evidence that we enjoy genuine competitive advantage over other nations, and this advantage will have been increased rather than diminished by developments during the Second World War. It is noteworthy that the goods in which we have been able to compete most successfully have generally been the products of our high wage industries rather than those in which low wages have prevailed.

☆ ☆ ☆

It is clear that, on a price basis, we shall be able to compete successfully in postwar markets in numerous lines. It is equally clear that such an opportunity is by no means of negligible importance to our own economy as a whole. During the years in which the censuses were taken between 1909 and 1939, our exports amounted

to from 7 to 16 per cent of our entire production of movable goods. In the year 1938 our exports in each of the following lines accounted for more than 18 per cent of total domestic production of the particular product.

(The figures in parenthesis are the percentages of total production exported.)

CRUDE MATERIALS: Phosphate rock (51.5), cotton (30.5), tobacco (29.4).

FOODSTUFFS AND BEVERAGES: Linseed (49.4), dried fruits (36.2), canned sardines (29.4), rice (21.0), fresh pears (15.9), canned salmon (13.8), canned asparagus (13.2), canned fruits (13.0), wheat (12.2), lard (11.7).

SEMI-MANUFACTURES AND FINISHED MANUFACTURES: Refined copper (53.1), paraffin wax (46.3), gum turpentine (42.8), carbon black (40.8), gum rosin (38.0), borax (35.9), crude sulphur (35.6), aircraft and parts (26.8), office appliances (22.3), carbons and electrodes (21.8), printing and bookbinding machinery (18.2), agricultural implements and machinery (17.0), biologic pharmaceuticals (15.3), industrial machinery (14.4), dental instruments and supplies (14.3), automobiles (14.1), benzol (13.3), goat and kid upper leather (12.8), refined lead (12.0), radio apparatus (11.8), caustic soda (11.4), refined mineral oils (10.8).

It is of major concern to all engaged in these lines of activity and in many others that foreign markets be not closed to us. It is particularly to our interest to have export outlets for our war-expanded capital goods and equipment industries. Since we undertook an important percentage of such expansion in order to furnish munitions to our Allies, it is reasonable to ask their cooperation in cushioning what inevitably must be a drastic readjustment here. The case is strengthened by the fact that the postwar world will desperately need the equipment items that we, alone, can supply.

But our demonstrated ability to compete on a price basis will not, of itself, assure us of foreign market outlets. Transportation costs, quality of product, marketing skill, technical and repair service—all are basically important. Still more important are non-discriminatory open markets and the command of dollar exchange by prospective purchasers. Our export potentials will surely be cramped in a world organized on the basis of bilateral deals and exchange controls. The availability of dollar exchange must depend upon the level of American imports and the volume of American capital loans.

☆ ☆ ☆

How are we to explain the skepticism of other nations toward an order which to us seems so clearly to represent not only our interest but the long-range interest of the world as well?

Soviet Russia, of course, is committed to conducting its external trade through its central government. But what of the United Kingdom? Why are there so many British voices that counsel the abandonment of what has been Britain's traditional position for more than a century? If we can understand that, we shall understand the dissent from our position of most nations whose economic positions have weakened and whose fiscal problems have multiplied during the two World Wars and the ill-starred period between them.

Essentially, their case is this:

Partly, they were forced into managed external trade policies by the Axis self-sufficiency programs, adopted in preparation for aggressive war. That can be corrected only by crushing the Axis, and by establishing a world security system that will make self-sufficiency a less compelling need.

But primarily, the reluctance of peaceably inclined nations to forego restrictive controls over postwar foreign trade stems from a deep-seated fear that is even more difficult to resolve. They fear, on the basis of past experience, that their efforts to meet payment balances arising from normal foreign trade would force a deflation of their internal economies, affecting prices, credit, wages and finally employment. Faced with the choice, as they see it, between making adjustments in foreign trade or in their domestic economies, they lean toward the former as, at worst, the lesser of two evils.

☆ ☆ ☆

Since the kind of world trade system we seek is dependent upon international arrangements to assure reasonable stability of exchange rates between national currencies, we are challenged to find a formula that both will provide this and at the same time allay what other nations believe are legitimate fears with respect to their domestic economies.

But at least two major steps toward resolving such doubts can be taken upon our own initiative without recourse to the intricate process of international negotiation.

One is the rational overhauling of our tariff system to provide other nations with increased opportunity to export to us. We can, and should, do this in a way that avoids undue cost to any segment of our economy.

The other, and probably the greatest contribution we can make toward winning a reluctant world to our point of view, will be to offer ample and convincing evidence that we are ready and able to provide a high level of employment in the United States. If we can do that, the rest of the world will wish to expose itself to our influence rather than to insulate against it, since prosperity here is the greatest single contributing factor to world-wide prosperity.

Balance of payment problems are minimized in a world of thriving trade. Britain would have little reason to resort to exchange controls if the total of postwar world imports and exports reaches an 80 billion dollar level. She may well be in a desperate plight if it should revert to the 1935 level of 40 billions.

☆ ☆ ☆

The United States wants a world in which private enterprise and competition play a major role. To obtain such a world will require a wiser, more understanding and firmer world leadership than this nation, or perhaps any nation, ever has exerted heretofore.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 33rd OF A SERIES

Continued Air Supremacy Needs THREE-WAY Research

IT IS EASY for us to sit in comfortable armchairs and speculate on the inefficiency and inaccuracy of the German V-bombs, but if we were to visit certain spots in England and Belgium we would cultivate a high respect for their effectiveness as instruments of wholesale destruction. Their use, in combination with precise meterology and brilliant tactics, during the December counteroffensive, brought the Germans to within but a few short miles of one of our largest supply dumps on the western front before we were able to turn the tide with tragically high losses.

Warfare is a continuing parade of such new weapons and counter weapons which, in this day and age, are the results of continuing research and development. Mankind is on the threshold of the discovery of forces so great that the most horrible destructive agents of this war will seem mild by comparison. And that is why we must never relax in our efforts to harness nature through continuous scientific exploration.

The responsibility for aviation research and development must be recognized by our legislators and shared by the government laboratories, our educational institution, the industry, and the armed forces. Each has a part to play, and the weakness of any link in the chain will impair our future security as a nation. The government research laboratories must continue to build a solid foundation of basic research and add to our fund of pure scientific knowledge. Their activities must be coordinated with that of the individual educational institutions for best over-all results.

●

NEXT STEP IN THE PROCESS is the application of certain portions of the fund of basic data to practical aircraft, engines, or accessories designed for specific purposes. This important step has been, and must continue to be, the responsibility of the industry operating under a competitive system. Procurement policies must be such that design development by industry is encouraged. We must not go back to the extreme rugged individualism of the prewar system where a manufacturer who lost a design competition was in danger of going out of business.

The Army and Navy must continue their work of design evaluation and set high standards of performance for the industry to shoot at. Application of new designs to changing tactical principles is also the responsibility of the armed forces.

All this may sound expansive and it is. But when you remember the scale of the prewar technical establishments of our enemies and our allies the item of cost becomes less important. At that time, the German and Russian research facilities were far more elaborate than our own. Paradoxically the totalitarian Germans retained a sort of competitive system in their aircraft industry, with entire plants devoted wholly to design development while others were responsible for quantity production, and all operating on a profit system controlled only by excess profits taxes. The "uncreative" Japanese had aviation research projects in their best universities and kept themselves particularly well informed as to the progress of other countries. Even the impoverished Italians built and operated the entire "Aeronautical City" of Guidonia as a center of aviation research.

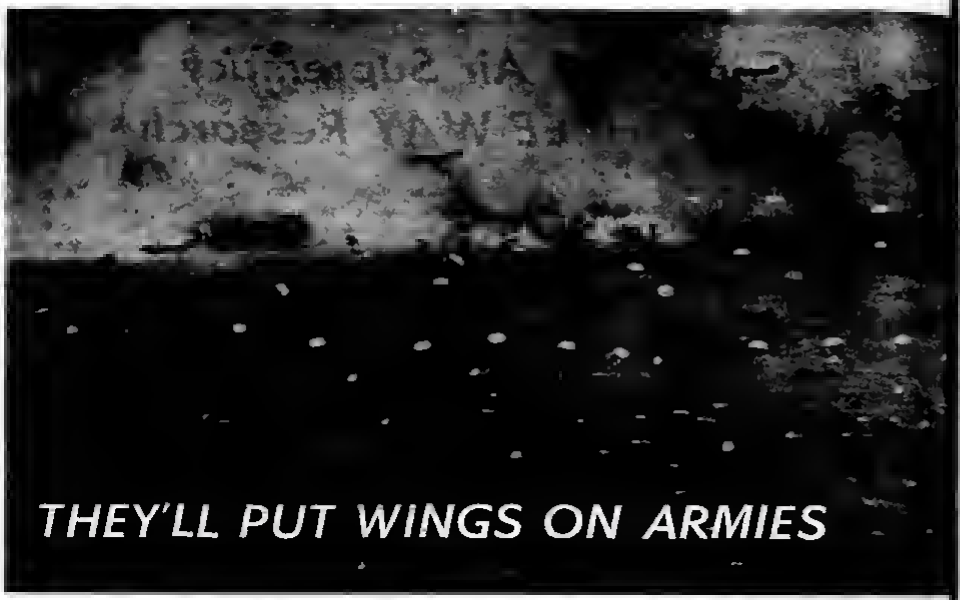
THE TECHNOLOGY OF FLIGHT is far from crystallized. From the beginning it has consisted of fairly long periods of rapid evolution of equipment punctuated by occasional revolutionary discoveries like rotary wing aircraft and jet propulsion. Each new discovery opens vast new fields for new development without obsoleting the old, because we are dealing not with a mere vehicle but are exploring a whole new medium of transportation which will be inhabited by many different types of vehicles performing very different missions.

It is important that our legislators realize these facts and that our industry lay the groundwork now for a period of research and development unparalleled in the history of technology.

To assist our legislators and our other readers in understanding the current accomplishments of government research, which have been veiled in wartime secrecy until recently, we present the article on page 113. And to help our manufacturers profit by the experience of other great industries in the organization and operation of research facilities we are offering an outstanding series by K. R. Jackman, the third article of which begins on page 143. These and other similar articles should be studied thoughtfully by government and industry so that policies can be formulated now to enable our postwar technological development to progress with continuity and at such level that we will remain the greatest air power on earth.

Jerald E. Tinkler

EDITOR



THEY'LL PUT WINGS ON ARMIES

Paratroops come out of Douglas C-47's over New Guinea—a single phase of this striking long-range airborne operation. An infantry unit was also flown 1,400 mi. from Brisbane, Australia, to Port Moresby, then over Owen Stanley mountains to battle front. And weekly average of 2,000,000 lb. of supplies were delivered by air. (Official AAF photo)

By BRIG. GEN. WILLIAM D. OLD, *Commanding General, 1st Troop Carrier Command, AAF.*

How a revolutionary new war arm—devised by the AAF and given highest impetus by the TCC—is set up and functions . . . and a glimpse of the great potential of "vertical envelopment."

A MAJOR REVOLUTION is afoot in mankind's age-old concepts of warfare which will be perhaps just as upsetting to present day theories of tactics as the abandonment of the British Square after the days of Kipling's Fuzzy Wuzzy.

In World War II, the combatants for the first time have been forced to contend with an entirely new dimension in their calculation of both the offense and defense—the air.

It is true that aviation played a considerable part in the prosecution of World War I, but not at all in the same sense that it does today, and even less in the sense it will tomorrow.

This new theory of warfare is based on the very simple fact that it is possible to use airplanes as transport vehicles. They can carry troops, weapons, and supplies in the same fashion that these items ware first carried by horse carts, and later by trucks and trains. But airplanes can carry them to greatly different places and a great deal faster.

The way in which this revolution has come about (also the trend which it can be expected to take in the future) is to a large extent the story of the Army Air Forces' newest major branch—the Troop Carrier Command.

Troop Carrier aviation is the Air Forces' answer to the classic military doctrine of getting there first with the most. The rôle of the Ground Forces in this concept is to supply airborne divisions particularly trained and equipped to enter combat from the air.

This team of Troop Carrier and Airborne Forces has already participated in operations in Burma, Sicily, New Guinea, Normandy, Southern France, and Holland. The greatest invasion in history—the assault on the continent of Europe—was spearheaded by almost a thousand Douglas C-47's carrying paratroops. These same Troop Carrier airplanes, in a cross-Channel shuttle service, brought reinforcing troops and equipment into Normandy by gliders.

Our experience in the European theater evolved an entirely new doctrine—that of an airborne army, an army which groups under one command both ground and air forces, an army able to strike in any direction probably thousands of miles from where enemy intelligence last placed it.

While the AAF first experimented to dropping soldiers and their weapons by parachute many years ago at Kelly Field, the Russians pioneered in the training of large numbers of paratroops, and the Germans first used them tactically, being successful mainly because of the lack of preparedness of the opposition. It remained for the American army to plan and develop the technique of "vertical envelopment" on the tremendous scale now being practiced.

It is to be expected that airborne attacks will increase in frequency and weight during this war. Today the Troop Carrier Command, organized in Apr. 1942, looks upon recently developed aircraft and war equipment as the auspicious beginning of a new kind of military power. We expect that troop carrier airplanes will be designed around all the tanks, field guns, trucks, tractors, bulldozers, field hospitals, kitchens, and every kind of weapon, equipment, and materiel that armies now use or plan to use. All ground forces may now be called potentially air transportable.

The Army is taking every opportunity to ride faster and farther and carry more things by air. Probably no person today would risk predicting a limitation on airborne warfare. How far air transport of ground forces will go in this war depends only on its duration.

Visualize for a moment a great offensive of the future. The commanders have discovered a strategical weak spot in the enemy's defensive position—not in his front lines, but several hundreds of miles within his own country. It is a spot surrounded by an admirable road net leading to several of his leading industrial cities, cities where a large percentage of his war manufacturing plants are located.

"We will fly an army in to this point," says the commanding general. "Our armor and infantry will base themselves in this area and launch an offensive to captore or industrially neutralize cities A, B, and C. Supplies and ammunition of all types will be delivered by air to the central area throughout the operation."

"In Terms of a Full Campaign"

The general discussing this operation is *not* talking about relatively small numbers of specially trained paratroops or glider troops selected for a short-term operation behind the enemy's lines after which they would expect to be relieved by ground troops. He is talking in terms of a full campaign—possibly of several months duration—completely air-transported and air-supplied, and independent of any concurrent ground action which may also be scheduled at the time.

So far no airborne operatioes on such a scale have been attempted, but their steady increase in size and scope since 1942 is a harbinger of what may be expected in the future.

Leading up to the recent airborne attacks on Normandy, South France, and Holland were several smaller operations in various theaters. In 1942 an infantry unit was flown 1,400 mi. from Brisbane, Australia, to Port Moresby, New Guinea, thence over the Owen Stanley range; and a weekly average of 2,000,000 lb. of supplies were delivered to this unit by C-47's. The first Allied use of gliders in large numbers was in the invasion of Sicily, in July 1943. For the Battle of Salerno, over 3,000 paratroops were dropped to reinforce a flank.

In the re-conquest of Northern Burma, from start to finish, the victorious Chinese-American forces were supplied by air—with weapons, food and medicines dropped by parachute, free-dropped, or air-landed. This task represented a revolution in logistics—the supply of a large military force by air for a campaign lasting one year.

Gen. Wingate's expedition into North Central Burma demonstrated a new military doctrine, the air delivery far to the enemy's rear of large ground forces, including animals, and thereafter supply by air for a period of many months of operations. This new concept of warfare was made possible by gliders, which first landed equipment and a body of engineers who constructed landing strips in record time. To the latter flew transports carrying troops and animals. These flights were over impenetrable jungles from bases in India, 250 mi. to the west.

In two different sectors of the British front on the India-Burma border, the Arakan nesr the Bay of Bengal and the Imphal Valley, in the Chin Hills, entire divisions were isolated when surprise Jap attacks cut surface lines of communication. In the Arakan it required three weeks of air supply before the embattled troops restored the situations. In the Imphal campaign an entire Army Corps was not only supplied by air for three months of fierce battle, but an entire division plus two brigades were flown inside the encircled area as reiniorcements. This turned the tide. Famed in World War I was the "Lost Battalion's" stand. Here, though, were divisions—a whole corps—in a much worse plight. Troop Carrier Command enabled the transformation from threatened defeat to victory.

On D-Day in Normandy, three fully equipped airborne divisions, two American, and one British, were put down behind the German forces and given the task of isolating German reserves on the Cherbourg Peninsula while seaborne troops assaulted the beaches. Gen. Eisenhower said that without success of the airborne mission this historic assault on Europe might well

Supplying large tactical forces by air is not a thing of the future—it has already been successfully employed in this war. Here Troop Carrier Command personnel load equipment chutes in special carrier racks on bottom of C-47 fuselage.

have proved to have been an impossible venture.

Out of these experiences grew Lt. Gen. Lewis H. Brereton's 1st Allied Airborne Army. On Sept. 17, this flying army, consisting of American, British, Polish, and French units, landed behind the German forces in Holland. For 14 days the operation continued in the face of bad weather and strong opposition of the Luftwaffe. Over 4,000 aircraft and 2,800 glider sorties were flown during the first four days of this operation. While there were some losses because of flak, not a single Troop Carrier aircraft was shot down by enemy fighters due to the magnificent cover by thousands of fighters and bombers of the American 8th and 9th Air Forces and of the Royal Air Force.

The American divisions were resupplied and reinforced and their casualties were evacuated by air, and they succeeded in holding open corridors through which advancing ground units later joined them. However, weather interfered with the operation of supplying the British Division. Despite that and the heavy attack by the German army, the division seized all of its objectives and held out for nine days, while Allied ground forces tried vainly to join them at the Arnhem crossing of the Lek. As a result, the hard-won bridgehead was lost. But though the British lost their objective, they frustrated the enemy's plans and the over-all operation resulted in important Allied gains.

Much press discussion of the British division's losing battle created an impression in this country that this great airborne attack had been a failure. On the contrary, it was a success of such significance that it hastened the Army's effort to develop new equipment and techniques for great airborne operations of the future.

Troop Carrier Command crews performing the primary mission of troop carrier aviation—transportation of airborne troops into combat, using transports, gliders, and parachutes—not only fly through flak and enemy fighters while confronted with the most difficult avigation problems in military aviation, but glider pilots, after landing, join their passengers in battle on the ground. Troop Carrier's secondary mission, resupply and evacuation of the wounded from the combat area, is also a dangerous one.

Broad Training Program

Troop Carrier units were trained by the 1st Troop Carrier Command, with headquarters at Stout Field, Indianapolis, Ind. and nine bases scattered throughout the East and Midwest. Displaying its insigne depicting a falcon delivering a paratrooper, the command, in addition to training Troop Carrier crews, assists in training airborne and other ground forces personnel and cooperates with other branches of the Air Forces in developing new Troop Carrier aircraft, gliders, and equipment.

The Airborne Center, with headquarters at Camp Mackall, N. C., trains airborne units of the ground forces. The Army's Parachute School is located at Fort Benning, Ga.

All paratroopers are volunteers, and glider troopers are specially selected. The rugged combined training of Troop Carrier and Airborne forces that puts both the "carrier" and "carried" personnel in shape for battle has already become celebrated.

The combat zone air evacuation service of Troop Carrier units includes facilities for instantly converting Douglas C-47's and Curtiss C-46's into flying ambulances. These are manned by skilled evacuation crews, including flight nurses, and with them go all necessary equipment, instruments, and medicines. The airplanes usually make their trip toward the front loaded with supplies, then install stretchers to evacuate the wounded on their trip back.

Experience has taught us that swift action in the care of the wounded not only saves thousands of lives, but also immeasurably improves the morale of those not wounded. Men who realize that, if hit, they will receive quick attention equal to that available in any modern city hospital, are able to face the most gruelling battles in a better frame of mind.

In addition to their primary mission of transporting troops into combat, Troop Carrier aviation also carries the Airborne Aviation Engineers who follow up advancing ground troops to rapidly build and repair damaged airdromes. When the engineers get an assignment to construct a runway perhaps hundreds of miles away, they load their specially designed miniature tractors and bulldozers into Troop Carrier C-47's or gliders. In a remarkably short time a landing strip is prepared that will accommodate even heavy bombardment aircraft.

Our flying equipment at present consists of the excellent C-47 which carries 4,000-6,000-lb. and the C-46 which carries about double the load of the C-47. We also contemplate using the Douglas C-54 and the new Fairchild C-82, the latter having the lift and bulk capacity to carry most of the items of the standard infantry division.

Our standard glider is the reliable Waco CG-4A which carries about 3,700 lb.—15 fully-equipped men, or a jeep and six men, or a 75-mm. pack howitzer with crew, as well as other similar loads. Parallel with improvements in aircraft, new gliders of great capacity are being developed and tested. Some will be used for initial assault, other types for equipment hauling. Tow ships and gliders of the future will lift unbelievable loads.

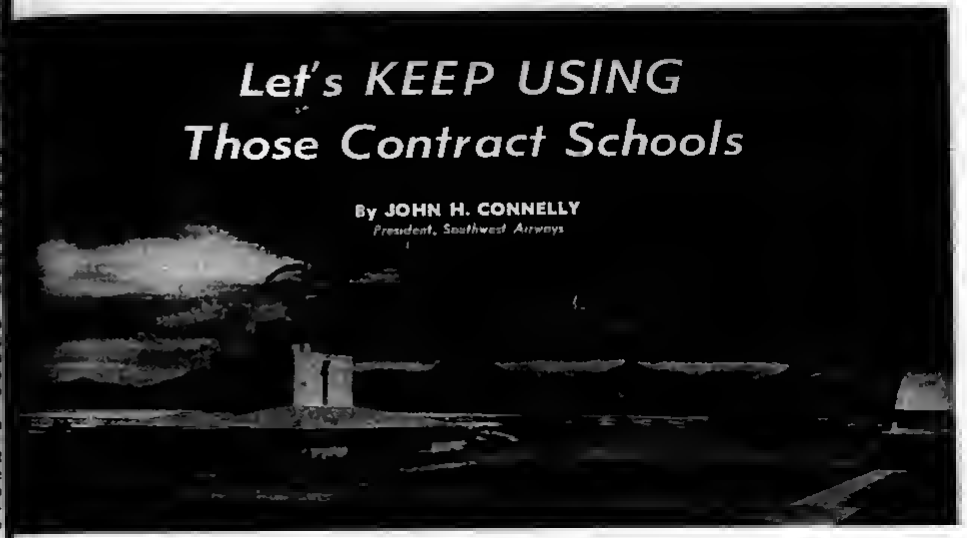
Airborne operations are limited at this time mainly by the capacity of the Troop Carrier aircraft available. The secondary limitation is the suitability of guns, tanks, bulldozers, tractors, and other supplies for air transportation.

The Fairchild C-82, newest craft of its type, along with other innovations for the use of an airborne army, marks only the beginning. Bigger planes to carry practically everything that the Ground Forces use, or expect to use, will be developed. Research is going ahead without stint of skills, manpower, or materials.

Standard glider of Troop Carrier Command is Waco CG-4, shown here just after landing in maneuvers. "Parallel with improvements in aircraft," says Gen. Old, "new gliders of great capacity are being developed and tested. Some will be used for initial assault, other types for equipment hauling. Tow ships and gliders of the future will lift unbelievable loads of equipment and men."

Let's KEEP USING Those Contract Schools

By JOHN H. CONNELLY
President, Southwest Airways



Besides providing a pattern for fixed base operations, nation's 44 ATS flight training schools have broad potentialities — hence they should not be allowed to lapse once they've completed their present vital war jobs.

WITH INCREASING FREQUENCY, three questions crop up in discussions of contract pilot training schools.

"What," I am often asked, "has been the contribution of your own schools in the so-called Air Age? What, actually, does it mean to the aviation industry aside from proof that your schools have flown more than 1,200,000 hr with some 18,000 cadets? And, just what is going to become of such schools as yours—have they any place in the postwar picture?"

I believe I can give at least partial answers, but first let's get the record straight. It isn't what we at Southwest Airways and our million-odd hours alone have contributed; it's the contribution, collectively, of all 64 Aeronautical Training Society schools that in 1939 undertook to give the all-important primary flight training for our Air Forces. Many of the administrative, instruction, and maintenance shortcuts which made possible our total were adopted from other civilian contract schools.

In that light, let us consider some of the possibilities:

First, there can be no postwar Air Age unless thousands of airminded men and women want, need, and proceed to use aircraft. What is more natural and logical but that a large percentage of the more than 200,000 Army pilots which the civilian schools have trained will be the nucleus of that group? And that, as they fly, their wives, parents, and brothers inevitably will realize the advantages of air travel, too?

Of course, a certain proportion of these young men would have learned to fly in the normal course of events. And, of course, if the civilian schools never had entered the training program, sizable numbers of pilots would nevertheless have been taught to fly by the Air Forces. But each would have reduced the total possible market as it now exists and, in turn, that proportion which would have used the air in the years to come.

I most certainly do not predict that the day is just around the corner when each of us will have a plane in a home hangar. Nor do I think it possible that we can now accurately foresee the number of returning military pilots who will wish to have craft of their own. But there will be many who will. This means business for our aircraft factories and all the related aircraft industries—tire, instrument, wheel, and engine manufacturers, etc. Moreover, these same planes will require servicing, special repairs, and periodic overhauls, thus providing aviation employment for additional thousands of workers.

Nor should we overlook the numbers of people who have been employed during the war by the civilian training schools. A sizable number can be expected to become customers of our peacetime aviation industry.

The possible multiplications are almost endless. Military and civilian personnel training in flying, dispatching, meteorology, avigation, maintenance, radio, etc., will search for postwar jobs of a similar nature. Undoubtedly positions will be found for many of them in a vastly-expanded air transport industry, which undoubtedly will include a system of feeder lines.

Second, let us consider safety. By all means, let's not sell short the important advancements in this phase of

America's ATS flight training schools can well become important parts of its aviation industry by conversion to fixed base operations to provide work for war-trained personnel, such as these maintenance workers at Southwest Airways' Thunderbird Field. Without exception, says Author Connelly, they provide a good blueprint for future fixed base operators.

aviation, nor the many contributions thereto of the civilian schools

We need only remember that during World War I there was a training fatality for every 1,146 hr. flown; comparing that to the average for all civilian contract schools of this present war—43,478 hr. for every fatal accident—we see the extent of improvement. As a matter of fact, here at Thunderbird Field our record is 1 to every 130,000 hr. flown. Safety has improved at least tenfold in the past four years alone.

We have learned not only how to achieve safety, but also how to teach it to others. In the years to come, this achievemcot may be regarded as one of the most important contributions to aviation of this decade. For with general public acceptance of the fact that the air can be a safer travel medium than even the highway, one of the few remaining major obstacles to universal use of the airplane is overcome.

The flight instructors of today, and the cadets who were their pupils, will be the instructors of tomorrow. The value of safety is so deeply impressed upon them that it will always be present in their teaching, regardless of who their pupils may be.

At a field such as Thunderbird, where we have flown as many as 1,136 hr. in training in a single day and where 850 hr. was the daily average during peak operations, safety methods must be learned quickly. Tomorrow's students also will learn that even though there may be as many as 50 planes in the traffic pattern, takeoffs and landings can be made without incident

At the civilian schools there are hundreds of dispatchers experienced in helping maintain safety through correct handling of heavy traffic. Places should be found for them at busy civilian airports where their war-gained knowledge can be fully utilized. Those meteorologists who have sent thousands of embryo military pilots on long-distance day and night cross-country flights with accurate weather information can perform the same function for peacetime flyers

The list of civilian school contributions to the aviation industry of tomorrow does not end there, either.

No one can deny the effective manner in which we have slashed the cost of training pilots and, at the same time, lowered the elimination rate. Each has a definite carry-over value to future training of would-be pleasure and commercial pilots.

According to the testimony of a high-ranking Army officer before a Congressional committee in 1938, it then was costing the Army $55 per flight-training hour. Our rate today is more than 80 percent less than that.

The same holds true with respect to eliminations. Before the war it was not unusual for as many as 45 percent of a single class to fail; today, eliminations average less than 20 percent, and we have trained classes in which it was almost half again as low.

Equally rapid strides have been made in civilian schools' flight maintenance departments. It never would have been possible for Southwest Airways to operate, service, and maintain as many as 544 airplanes daily had it not been for the introduction of "production line maintenance" and an overheul depot in which major repairs and overhauls were mass produced. (See page 213, June 1943 Aviation.) Faster, cheaper, better maintenance has resulted, to the everlasting benefit of the industry.

It is not too early to begin thinking about the future of these schools which have done their work so well as in the war emergency, both civilian contract schools to the Army, such as Thunderbird, and the many which comprised the CAA's War Training Service. In a majority of instances, these have been operated by the so-called fixed base operator. What is to become of him and of his schools?

The latter program has reached the termination of its activities; the former is approaching that point.

Let us first consider the physical aspects of the training schools. Originally, these schools probably averaged $200,000 in cost, and some—Thunderbird Field included—ran considerably more than that. Almost without exception they were later increased in size. Thunderbird is nearly typical of such plants. It covers 640 acres and has three auxiliary fields of 150 acres each. Its buildings are pleasing to the eye, decorated in soft pastel shades which blend into extensive landscaping and green lawns. There is an administration building, dining hall capable of feeding 250 at a sitting, ground school and Link trainer, instruction rooms, large recreation and canteen buildings, maintenance hangars and, of course, numerous barracks.

The buildings, extensive landscaping and two large swimming pools, have all been the basis of an environment conducive to the best in pilot training.

Why not, then, utilize the beauty of the contract schools, and turn them into temporary hospitals, reassignment or rehabilitation centers for returning veterans?

After all, these installations are ideally located from a climate standpoint. Almost all of them are below the 35th parallel of latitude, the South having been chosen because it afforded year-around flying weather. Also, all are located within a reasonable distance of cities of varying sizes.

Each operation already has a small hospital unit, and all have bay-type, four-to-a-room or larger, barrack layouts. Normal barrack capacity of Thunderbird, for example, is 350 beds, although during the training peak we housed as many as 817 cadets. Multiply these facilities by 64, the number of contract schools in the nation, and one begins to see the potentialities of such a step.

These are suggestions for use of facilities already idle and those few additional ones which will become idle when the pilot training job is completely done. Purely from the standpoint of an individual taxpayer, I dislike seeing a government-owned installation lying idle if some practical, economical use can be made of it. And that particular point undoubtedly bears some explanation, for it may not be commonly known that these 63 civilian training schools now are owned by the United States government through the Defense Plant Corp.

Originally, most of the schools were built with private capital. Later, they were purchased by DPC to enable the civilian operators to obtain a fair return on their unexpectedly large investments and thereafter they were simply leased from DPC by the operators—at, I might point out, rates which far more than repaid the government its entire investment.

Completion of their war duties is no reason the 64 ATS contract schools should forthwith be idle, declares author. Facilities, such as these, make them ideal for rehabilitation centers, hospitals, or schools under GI Bill of Rights.

ATS and CPT schools could easily serve as postwar aviation colleges, with little or no modification. Transition would mean little more than changing uniforms of these cadets for "civvies," then flight training of American youth could continue uninterrupted.

Thus, if the schools should be utilized as hospitals, reassignment or rehabilitation centers, it should be entirely a government operation by government with government facilities.

A second possible use for the schools would involve continuing their operation on much the same contractual basis as at present, with the civilian operators leasing them at a nominal figure in order to continue the AAF civilian training organization teamwork which has attained such success during the emergency.

I think that today all of us agree that the United States must maintain an effectively large peacetime Army, Navy and, particularly, Air Force. That means some type of mass military training, either voluntary or compulsory, will be necessary. For our Air Forces, we might well continue to count on the civilian-Army team to supply future pilots.

Pilot Pool Essential

While we cannot accurately anticipate the demands which future events may make on aviation in the United States, we can and should maintain a pilot pool adequate to meet all emergencies. Prior to our cotrance into World War II, we had but one training center for combat pilots (at Randolph Field, Tex.) which turned out approximately 275 qualified pilots a year. Between World War I and the present war, our Army trained only about 4,200 pilots, whereas with the 64 ATS schools and the stepped-up program, more than 110,000 now are being trained yearly.

I do not recommend that we should continue to develop military pilots at this pace, but neither should we return to the prewar rate. And, the fact that pilots become "over-age," generally speaking, for effective military combat service after they are 26, makes it important that we do not delay too long in starting our training programs.

Besides our military training schools, I believe we should foster and continue Civilian Pilot Training. America today has the greatest air power in the world, and it is the youth of today who will have to maintain that position.

Besides providing a backlog of military pilots, a CPT program would bring about more popular interest in flying, which, in turn, would stimulate industry and the advancement of aviation as a whole.

Speaking of a military backlog, in 1940—more than a year before Pearl Harbor—every youth selected for the CPT Program signed a pledge that in the event of war, he would join our armed forces. When the war did come, CPT was responsible for the fact that over 120,000 trained young men were available almost immediately.

Expansion of commercial aviation will require young, alert, highly trained men for specific tasks. We cannot depend entirely on returning veterans to fill this need, for many of them will not wish to make aviation their career and others will be too old. Although many will have thousands of military combat hours to their credit, this does not necessarily mean they will be able to pass the strict CAA qualifications for airline pilot, or other positions in commercial aviation, without additional training. To be entirely realistic, we must concede that war-bred, to-hell-with-safety flying makes one kind of a pilot; the peacetime, safety-is-foremost approach makes another. It seems to me there is a positive need now to train our youth for the future, and I know of no better way than ATS and CPT programs.

The possibilities for continued use

of the civilian school training facilities don't stop there—far from it. The proposals outlined here are merely among the most obvious and immediate. There is still a third possibility, and it is to this one that I would like to direct all possible attention.

In brief, it is that present and former operators of these fields, or other fixed base operators, avail themselves of the opportunity to purchase the installations from the government.

Transformation Features

Speaking entirely personally, it does not require too great a stretch of imagination to see each of the contract schools transformed into a commercial operation. Because of variations in location and extent of facilities, obviously not all of them are suited for every kind of an operation. However, let us examine just a few of their potentialities for a moment:

As veterans' technical training schools. Little or no modification of existing facilities would be necessary to make the average contract school an almost ideal facility for giving aviation training under the G.I. Bill of Rights. Courses could include not only actual flight training but also technical training for those who wish to become mechanics, dispatchers, radio operators, meteorologists, etc.

The barracks, recreational, and dining facilities are completely adequate without change. Moderate investments in additional instructional equipment probably would be necessary, and aircraft for the actual flight training undoubtedly could be obtained from the Surplus War Property Administration at little cost for this particular type of an operation. Moreover, all contract school operators have had sufficient experience with military classes of various size to know the volume of enrollees required to make such a venture a financial success.

As comprehensive fixed base operations. The certain upswing in all types of private flying after the war will require great numbers of fixed base operations. These could be the "here today, gone tomorrow," coffee-and-hamburger type which was so common before the war, or they could be attractive, stable organizations having a definite place in the community's economic life. We know from experience that the former seldom, if ever, is either a credit to the aviation industry or a desirable business occupation for the operator himself.

We also know from the experiences of the handful of prewar operators which fell under the latter description that they were a very worthwhile business enterprise indeed.

I am sure that most fixed base operators realize they cannot hope to achieve economic success by operating off the old, dusty airport of yesteryear. On the contrary, every effort must be made to develop these field bases into attractive landmarks which, without losing their practicability, are as pleasing to the eye as the modern business house.

The contract schools meet this basic requirement very well. Thunderbird, for example, might well be transformed into a fixed base appealing not only to the aviation enthusiasts of Arizona, but also to itinerant private flyers. Certainly its facilities are adequate for giving all types of flight instruction to hundreds of students.

Facilities Are Ready

Its hangers are large enough to provide temporary or permanent storage for private aircraft. Maintenance facilities are suitable for public offering of routine servicing and major repairs and overhauls. Special flight and technical training courses could be offered to those who wished to live on the field and complete their instruction in the shortest possible time—the existing barracks, dining, and recreational facilities again being entirely adequate.

Some of the barracks could be transformed into showrooms for displays of new personal aircraft, or for lease to various dealers. Additional revenue undoubtedly could be realized by converting some of the facilities into a public restaurant, and by combining and remodelling barracks into attractive quarters of the hotel or auto-court type for temporary guests.

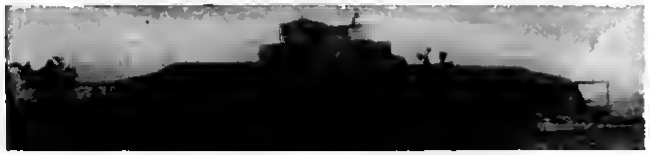
As our colleges. It seems quite likely that the postwar "Age of Flight" will have to provide for the thousands of 'teen-aged youngsters who will wish to make aviation their careers. They may be interested in becoming anything from aircraft engineers to flight instructors, and I see no valid reason why certain of the contract schools might not become, literally, aviation colleges.

It would be possible to offer training in any phase of aeronautics, not at all unlike that now available in any of the arts at the average university. By maintaining high standards of instruction it would be possible to award degrees based on the grade or credit system, so that students could be accredited either from a liberal arts university to the aviation college or vice versa without sacrifice of standing.

Such an operation undoubtedly would require converting a large number of the barracks into additional classrooms, but a sufficient number might be retained almost "as is" for those students who wish to live at the school. Once more, it is obvious that a majority of the present contract school facilities are completely satisfactory without modification.

These premises and conclusions which we have offered represent an incomplete job of exploring the realm of possibility for the contract school's future or, for that matter, the future of fixed base operators. But it does serve my primary purpose to point out that regardless of the particular type of commercial venture an operator chooses to establish, the physical properties of the average contract school fit in rather well. Barracks, swimming pools, athletic facilities, recreation halls, dining rooms, attractive landscaping—all are on the plus side. I am correct in my assumption that airports must keep step with the definite architectural trend toward structures which are designed for eye appeal as well as economic practicability. They are also items to which those planning postwar fixed base operations should give serious consideration.

Rather than be pessimistic over the future of fixed base operations, simply because so many of our youth have been trained to fly by the armed forces, I am optimistic when I think about the additional millions who will want to learn to fly so that they, too, can take an active part in the coming Air Age. I feel certain that the progressive fixed base operator—the one who is willing to incorporate imagination and a touch of the future in his place of business—has ample opportunity to become a financially successful cornerstone of our postwar aviation industry. That industry needs him and should do everything possible to help him become firmly established.



This control tower could serve in peace as well as war.

STAYING AHEAD THROUGH BASIC RESEARCH

By **ALLEN HARRIS,** *Fairchild Engine & Airplane Corp.*

Fundamental work by NACA on compressibility, cooling, stability, control, and other primary problems, has been a vital factor in American air supremacy, proving need for a sustained program to keep our lead.

No example of our industrial legerdemain has received more widespread and deserved recognition than that which skyrocketed American aircraft production from slightly more than 2,400 planes in 1939 to 86,000 in 1943. This production miracle wins a permanent place in history. Similarly, the constantly improved design of our warplanes has become a familiar story through literally thousands of newspaper and magazine articles.

Yet surprisingly little has yet been said about the research and developmental work without which better designs could not have been evolved nor production sharply increased. To an extent that all too few persons realize, research has accelerated improvements in the performance of American planes, materially aided in the simplification of designs, with consequent production gains, and added to the common knowledge of the science of flight.

Among the "Big Three" of governmental aeronautical research — The Naval Air Experimental Station at Philadelphia, the Air Technical Service Command at Wright Field, and the National Advisory Committee for Aeronautics—only NACA has as its specific purpose and basic *raison d'etre* the development of the science of flight, with equal regard for all of its applications, private, commercial, and military.

The Act of Congress which set up NACA in 1915 clearly gave the committee the entire vast horizon of aeronautics as its theater of operation. The duty of NACA, said the Act, shall be to "supervise and direct the scientific study of the problems of flight with a view to their practical solution". The significant words in the statement are "scientific study" and "practical solution," as any aircraft manufacturer will attest for from NACA scientific study has resulted the practical solution to problems which, left unsolved, would have made the 400-mi.-plus warplane a dream, the fiivver plane the harvest of hopes, and today's air commerce, purely visionary.

Planes germinate in the minds and on the drawing boards of aviation engineers and designers. They are still embryonic when the scale model and mockup are built. The task of NACA is to provide the fundamental data on which a new design is based and to assist in the research and testing work to bring the airplane to a satisfactory completion. In a very real sense, then, NACA serves as a technical midwife at the birth of American planes.

NACA performs its research duties at its own laboratories, coordinates the research done at other government-owned laboratories with that done at its own, encourages the conduct of research by other organizations and even by individuals, and in some cases —notably in the case of institutions, universities, and the like, that have suitable personnel and equipment—it supports all or part of their work. The NACA's three research centers are: Langley Memorial Aeronautical Laboratory at Langley Field, Va.; Ames Aeronautical Laboratory at Sunnyvale, Calif.; and the Aircraft Engine Research Laboratory at Cleveland, Ohio.

Oldest of these three is Langley (LMAL), for many years the only one. And many people have grown so accustomed to thinking of the Langley Laboratory at Langley Field that they merely call it Langley Field, quite ignoring the fact that the field is not a research center at all but an important and busy operating field of the Army Air Forces.

The Langley Laboratory, as the longest established, has developed most fully. Here the methods of organization and of work were first tried; here the first of the modern equipment was conceived, built, and proven to be workable as planned. The laboratory's history is a story of continual reaching for better, more accurate results, more usably expressed. This research has not been the research of fiction in which men lead lives completely di-

Importance of stability-and-control test work is indicated by work done in NACA tunnel built for that purpose at Langley Memorial Aeronautical Laboratory. Shown here are model and tunnel set-up for testing conditions corresponding to turning flight in horizontal plane. Vertical wires and deflecting plate ahead of model are part of equipment employed to obtain curving airstream. (Official NACA photo.)

Close-up of scale model of new Fairchild C-82 Packet cargo-paratroop carrier, mounted in conventional upside-down position in stability-and-control fast tunnel during tests covering loading gear fairing doors.

vorced from the working world. Rather, it has been a continuous endeavor, in close association with its world, to perceive the troubles that will distress the aeronautical world tomorrow and the day after, and the direction in which that world will develop, and to have ready against those days remedies for the troubles in order to expedite the development.

After Langley had become thoroughly established, the center of gravity of the aircraft industry began to shift, with the West Coast becoming a new center. The long-distance handling of the problems of this new group was believed to be basically wrong, so a new laboratory was established to give more prompt service to the Western aircraft industry (see page 123, Oct. AVIATION) Known as the Ames Laboratory, this installation started with all the experience of the Langley Laboratory behind it, and its equipment represents the best prediction that could be made of the needs of the growing industry.

Similarly, the problem of studying aircraft engines, with their almost infinite number of special problems, grew so great that a separate laboratory, especially equipped and located more nearly in the heart of the industrial area of the country, was constructed. Here again all the experience gained at Langley was used to make the new Aircraft Engine Research Laboratory among the best equipped in the world.

The Langley Laboratory remains the original Committee Laboratory and is still the largest of the three, both in personnel and area. It is not allowed to rest or become old fashioned; instead, it continues to pioneer with new ideas, new equipments, and new services for the aircraft industry.

Research work on the problems of flight conducted at Langley is done in one of the three departments into which the laboratory is divided. The Administrative Department handles administrative work, and the Technical Service Department provides all those technical services, drafting, designing, shops, and tools that are required by the Research Department in its work.

In order that the research efforts may be handled more efficiently, generally similar problems are allocated to one or another of eight groups, or divisions Each division has a staff of specialists and its own wind tunnels or laboratories. The eight divisions are as follows: Aircraft Loads, Compressibility Research, Flight Research, Full-Scale Research, Hydrodynamics, Physical Research, Stability Research, and Structures Research Each division has made large contributions to aeronautical science, as well as to the development of specific planes, engines and equipment.

Laboratory Triumphs

The Compressibility Research Division has, for example, increased the knowledge of the airflow around aerodynamic bodies at high speed and of the methods for designing or modifying those forms so that it will be possible to avoid the violent increases in drag and structural loads that accompany the development of compressibility effects which occur when approaching the speed of sound.

In this work, the problems of high-speed flight and the effects of compressibility on aerodynamic forms and bodies of all types, and more especially on wings, cowling, and fuselage, are studied both experimentally and theoretically.

It was discovered, for instance, that even with the best forms of NACA cowlings, compressibility effects on the cowls themselves began to be noticeable at speeds of about 320 mph. Increases in drag and other troubles appeared .A study was made in the 8-ft high-speed tunnel, and the cause of the trouble was found in the form of the cowl, which made it necessary for the air flowing over it to attain sonic speeds during part of its travel.

Accordingly, successive revisions were made in the cowl until a form was obtained in which the flow was so much improved that the compressibility effects disappeared At present, this is in general use on most high-speed airplanes using radial, aircooled engines, what is known as the NACA cowl, which is free from compressibility effects at sea level up to speeds better than 600 mph.

For many years, there has been intense interest in the question of what sections should be used in the blades of propellers. Most propellers turn at such high speeds that it is quite common for the tips to reach or exceed the speed of sound, in which case compressibility effects appear in the guise of noise and vibration. In addition to the compressibility effects at the tips of the blades, there are also compressibility effects at points along the blade. This toeans that the form of the cross section of the blade is such as to cause the speed over the blade to be above the speed of sound at these points.

Sections calculated to make the speed of the air at all points over the blade remain below the speed of sound have been investigated. In 1934, the data relative to some new sections of this type for use in propellers were published, but the sections did not receive very wide acceptance by manufacturers. The work of further improvement has continued, and propeller sections are available today that are much superior to the one proposed in 1934. Nevertheless, NACA personnel engaged in this work were, quite understandably, excited when they found that a section from the propeller blade of a German Me-110, shot down in 1940, had a section identical with one of those proposed in 1934.

It was in this division that the first demonstration was made of the fundamental character of compressibility effects on airfoils. These effects called for serious consideration, not so much because of the local excesses of the speed of sound, but because of the separation of the flow that was generated. As a result of this investigation, new airfoil sections have been devised that are relatively free from the occurrence of compressibility effects and which consequently are much better adapted for use in high-speed airplanes NACA low-drag airfoils incorporate the results of this work.

For the past several years a study has been conducted of the ram-jet theory in connection with propulsion. It was found that serious trouble was being encountered in the cooling of high-speed airplanes in which there were baffles for directing flow of air through the cylinders, because the velocity of sound was exceeded in the flow around the baffles. New baffles have been devised in which these compressibility effects are avoided and, while the cooling effect of the air over the engine is increased, the drag of the airplanes has been correspondingly reduced.

With the aid of the big wind tunnel, the Full-Scale Research Division began, in 1938, to investigate the causes of poor performance in airplanes. A plane, stripped of all excrescences and with its nose faired to a streamlined form, was placed in the tunnel, then the various scoops, slots, cowls, flaps, and other projections, which had been removed, were added one by one, and their effect on the drag of the airplane was determined.

Much to the surprise of aeronautic engineers, it was discovered that relatively small objects produced great increase in drag in many instances. So attention was given to reducing the increased drag by improving the form of the object. Here again the researchers had surprises in store for them. For example, it was found that the drag of a scoop of small dimensions often could be very much reduced by enlarging the scoop to several times its original dimension, providing the final shape was aerodynamically sound.

The division discovered that the importance of compelling air to leave the interior of the fuselage or wings at the proper positions had not been fully appreciated. A stream of air coming out of an opening at one point might increase the drag very considerably; yet the same stream of air from a proper location would have no effect. Striking reductions in drag have resulted from attention to this one apparently minor point.

In the course of this work, the effect on drag of the presence of scoops, canopies, guns, landing gear, and antennas, as well as other parts that must normally be fitted so that they project from the airplane, was worked out. Finally in 1940, a report was prepared in which all that was known at that time regarding the effect of such things was collected and put in a manual for the use of designers.

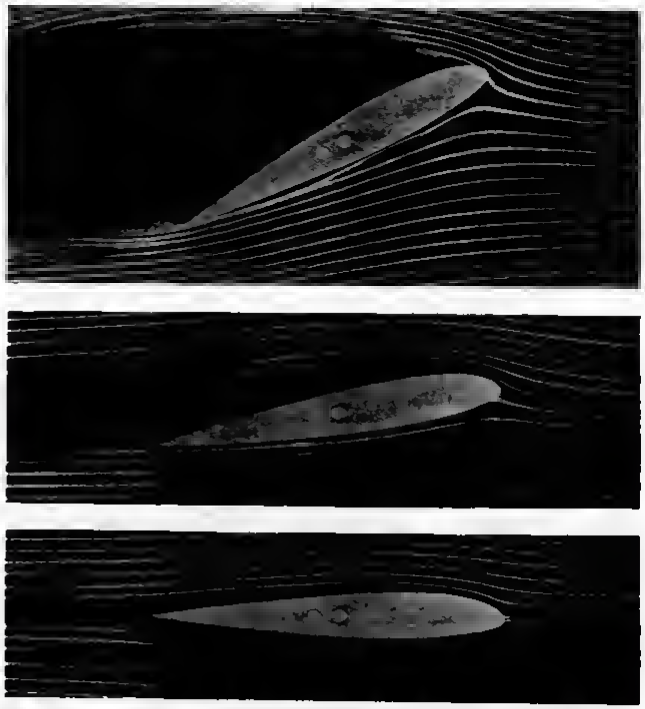
The effect of this work on aeronautical progress has been quite conspicuous. When it first began it was quite common for the decrease in drag obtained by cleaning up in the full-scale tunnel to bring an increase in the speed of from 10 to 60 mph. Of late, the gains have been uniformly smaller and the aerodynamic cleanness of the projections from the body of the airplane has been noticeably better. It is evident that this basic research is finding its way to every-day production use.

Through this process of cleaning up in the full-scale tunnel at LMAL have passed almost every U. S. military airplane of the past six years—certainly all of any importance in the prosecution of our present war. The series starts with the Brewster Buffalo, and includes the Vought F4U Corsair, the Grumman F6F Hellcat, the North American P-51 Mustang, the Bell P-63 Kingcobra, and other craft whose names and performances must still remain unpublished.

In the 19-ft tunnel, work has been psi—are of intricate construction and stability of nearly all of the new military designs. Models used in this tunnel—a pressure tunnel operated at 35 psi.—are of intricate construction and quite large They usually are fitted with active propellers driven by electric motors, and it is necessary to fit remote control devices for operation of the elevators and ruddera. The equipment used in these tests is extremely complex, but it makes it possible to measure a great variety of quantities.

In the two-dimensional tunnel, operating under a pressure of about ten atmospheres, work has continued on the improvement of airfoils. The effect of this work can be appreciated

(*Turn to page* 246)



Airfoils, which have been greatly improved by NACA basic research, are studied by many means, including smoke streams as shown here. Note smooth flow around foil in lower illustration; center view shows angle of attack increased to 10 deg., with airflow beginning to separate from upper surface; and when airfoil attack is increased to 30 deg., as at top, airflow separates completely from upper surface. Observe turbulence behind trailing edge.

HOW TO GET YOUR SHARE Of EXPORT SALES

CONCLUDING PART III OF A SERIES

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

Here's what to do for answers to many of the problems facing every manufacturer or distributor who wants part of the vital foreign trade market.

HAVING WON THE BATTLE of war production, the aircraft industry may now look ahead to a new battle—the battle of distribution. It won't be what the industry can produce in peacetime but what it can *distribute* that will count.

Manufarturers who get into foreign markets first with products that are within the buying power of other peoples will reap the benefit of the overseas demand that lies ahead postwar.

In our two preceding articles on foreign-trade factors, we pointed out how civilian transport has broken down the world over; how huge trade balances are held in this country by Latin America, India, and other trading areas clamoring to buy American goods; and how the industry faces competition from Great Britain, Canada, and elsewhere, meanwhile gaging the probable amount of this competition. Now, in concluding our series, we'd like to aid in charting a course for the aircraft producer who seeks a niche in Uncle Sam's ambitious postwar foreign trade program.

The manufacturer who enters foreign trade should expect—and plan—to do so on a permanent long-range basis. He should be prepared to protect and support his export program through its initial critical stage. He must weigh, pro and con, the advantages of (1) indirect exporting through experienced professional export middlemen, such as manufacturers' export agents, (2) having a combination export manager, or (3) setting up his own export organization.

Study must be given to the suitability of particular planes, parts, accessories, and instruments for the markets to which they are destined, and inquiry must be made into the ability of consignees to pay for shipments in a reasonable time.

The first avenue of approach may be to a banker who operates—and possibly has branches—in the chosen territory. The nearest branch of the Bureau of Foreign & Domestic Commerce of the Department of Commerce should also be consulted. It will be found that both the banker and the Bureau are equipped to furnish up-to-date information on overseas markets and their possibilities. From the mass of credit information which they have at their finger tips—all carefully documented and regularly revised—they are able to provide confidential opinions on the honesty and financeal standing of overseas importers.

Your banker may advise that a representative be sent to study the prospective foreign markets, to collate information, and to collect orders. If the manufacturer cannot afford to do this, he still may avail himself of the services of the many export houses that specialize in such operations. In that case he may be relieved of the financing problems, since these houses make their own arrangements with overseas bankers. The names of such export houses can readily be secured from bankers.

However, if the exporter wishes to build up his own foreign business he must again seek information from his banker on the various credits under which exports are financed. He will be shown how documentary bills of various types are used. Actually, it is usually found that the banks will assist in financing every phase of trade, from the purchasing of raw materials to the marketing of the finished product.

Officials of the foreign commerce bureau can furnish reports on the tastes, buying habits, and purchasing power of the populations of many countries. They can supply the answers, regarding specified foreign areas, on such business conditions as exchange restrictions, trade controls, effects of trade agreements, tariffs, laws, and regulations.

It is equally important for the new foreign trader to assess the many factors entering into the cost of exporting. Some of these costs appear small but become large in the aggregate. Goods cannot always be sold f o b the factory. It may be necessary to quote f.a.s. free alongside ship—American port or c.i.f.—cost, insurance, and freight—port of destination. So all the items that enter into export, such as packing, shipping, documentation, and the like, should have detailed study.

Eleven years ago Congress created the Export-Import Bank, a banking facility about which the average aircraft maker or distributor may know little but one that might be of great value to him in exporting. One of the purposes of this bank is to finance and facilitate exports, and it has broad banking powers to do so.

The bank (1) makes loans to foreign nations to provide dollar exchange so that American exporters' bills may be paid in dollars; (2) gives credit lines to small exporters and importers with good records for experience and business ability, but possessing limited capital; and (3) provides credits for Latin American banks for the establishment of letters of credit authorizing payments against certificates of completion, warehouse receipts, or other so-called "inland shipments."

The bank is planning to finance foreign trade through a discount agreement with the manufacturer. Under such a line of credit, the Export-Import Bank purchases or discounts the promissory notes or other obligations which the foreign importer gives to the American exporter. Such notes will be purchased to the extent of approximately 75 percent without recourse. The bank finances the manufacturer's out-of-pocket expenses for raw materials and labor, and the manufacturer finances his real overhead and profit.

The bank will, on occasion, according to vice-president Eugene LeBaron, finance the remaining 25 percent but with full recourse. To date such financing has been used by American manufacturers on many different types of goods.

Suppose, for example, an aircraft manufacturer wishes an export loan from the bank. The application is filed and reviewed by the officers of the bank to see if the project makes sense and if enough exchange will be available to make repayment. Then if more than $20,000 is involved, it is put before the board of trustees in Washington for approval. The bank also has a revolving credit line, limited to $20,000, which can be turned over many times through the commercial banks in New York.

Legislation is now before Congress to expand this bank's capital from $700,000,000 to around $5,000,000,000. This would supply additional funds for financing private export enterprises. The trend is definitely towards additional governmental facilities to aid in financing the small exporter.

Many more American manufacturers are developing their own export departments than was the case after the last war. Several companies have created an additional division to handle overseas operations. Because of war and manpower conditions, much of the export development is in the planning stage, but many concerns which never have paid much attention to export are getting themselves export managers and paving the way to start operations as soon as the green light is given for private foreign trade.

In fact now is the time for a company to line up a good man to head its export department, if the organization does not already have one. If he is new at the business he should join the nearest Export Managers club, the Foreign Credit Interchange Bureau, and any other foreign trade organization that can aid him in "knowing his way around."

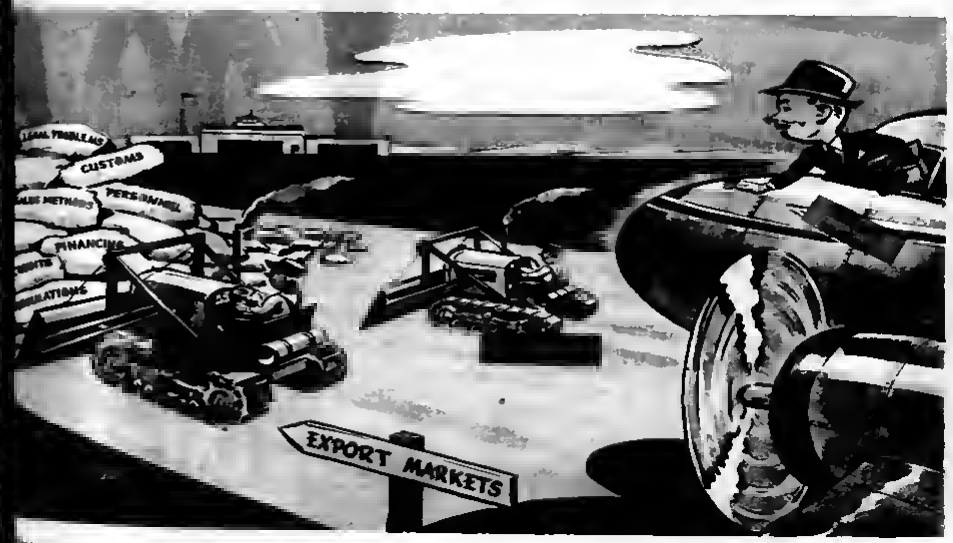
There are some company presidents who in their tyro consideration of establishment of export departments, place too much weight on the pertinent nationality of the prospective export manager—rather than on his experience. Numerous persons who initially came here from other countries to get their education like to remain in the United States to take positions in export work. But many of them have had no previous business experience either here or in their own country.

Overseas buyers often can testify to the pitiful manner in which their shipments, drafts, and the like, have been handled by inexperienced personnel.

Many export departments are too prone to rely entirely on their manufacturers' representative as to the advisability of extending credit to overseas buyers. As a rule, any foreign concern that desires credit should have to submit data to prove it has been granted credit by other American suppliers or has fully met its obligations over a period of years. Although some well-established foreign buyers have a natural tendency to feel piqued if their credit is questioned, it is well to tactfully check references, especially of those who give the names of firms here which do not readily "check in the book."

In conclusion, it is well for all exporters or potential exporters to bear in mind that in the long-run American exports will be limited by the imports we take from other countries. This is a fundamental of foreign trade. Any foreign nation can buy from us only to the extent of the dollar exchange which can be made available to its importers. If we consistently sell more to a certain country than can be paid for, someone here is not going to be paid.

If the aircraft industry intends to become a factor in American foreign trade, it should join all other traders in vigorously supporting the principle of two-way trade as the only means of building up permanent and healthy foreign markets.



DESIGN ANALYSIS OF

The North American B-25 Mitchell

By C. J. HANSEN, *Chief Project Engineer, North American Aviation, Inc.*

This distinctive gun-bristling medium bomber—first warbird to drop "eggs" on Japan—has again and again played a strikingly effective role in far-flung war performances. Here's a meaty presentation of basic B-25 makeup features and comparative details of models H and J. . . . The 11th in AVIATION'S peerless design analysis series.

FROM THE OUTSET of the war, the North American B-25 Mitchell medium bomber series has earned enviable reputation in the hands of United Nations pilots in all theaters of combat. Designed in 1939 and first flown in 1940, this plane has been developed through a series of changes brought about by tactical needs.

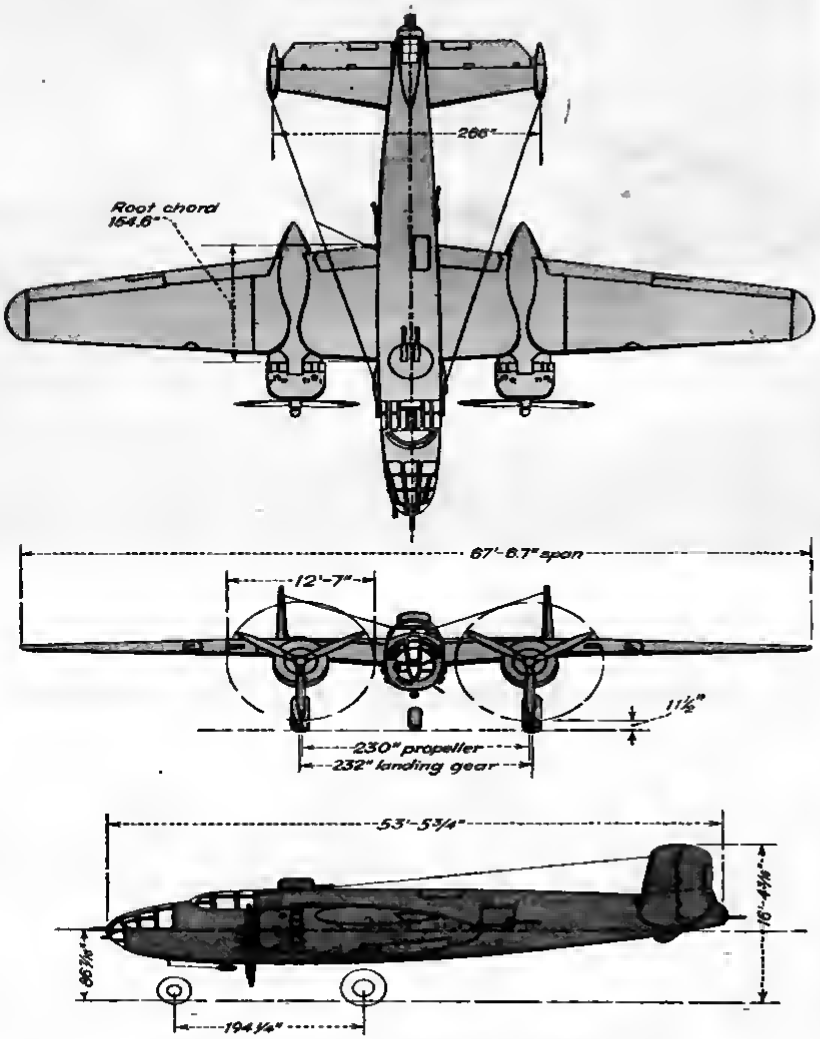
Latest models of the Mitchell to enter combat are the B-25H—outstanding among production planes for its extremely heavy armament—and the B-25J—latest improvement on the original medium bomber design.

These are pointed examples of North American's design policy of ease and economy of fabrication. In this instance the Mitchell was manufactured on the basis of 48 major assemblies, any one of which, theoretically, could be modified without necessarily affecting the other 47. The B-25 has undergone nearly a dozen such changes without altering the basic design.

In both models, firepower has been increased by addition of a tail turret, waist guns, moving the upper turret forward to improve field of fire, and two fixed forward-firing package guns on each side of pilot's compartment.

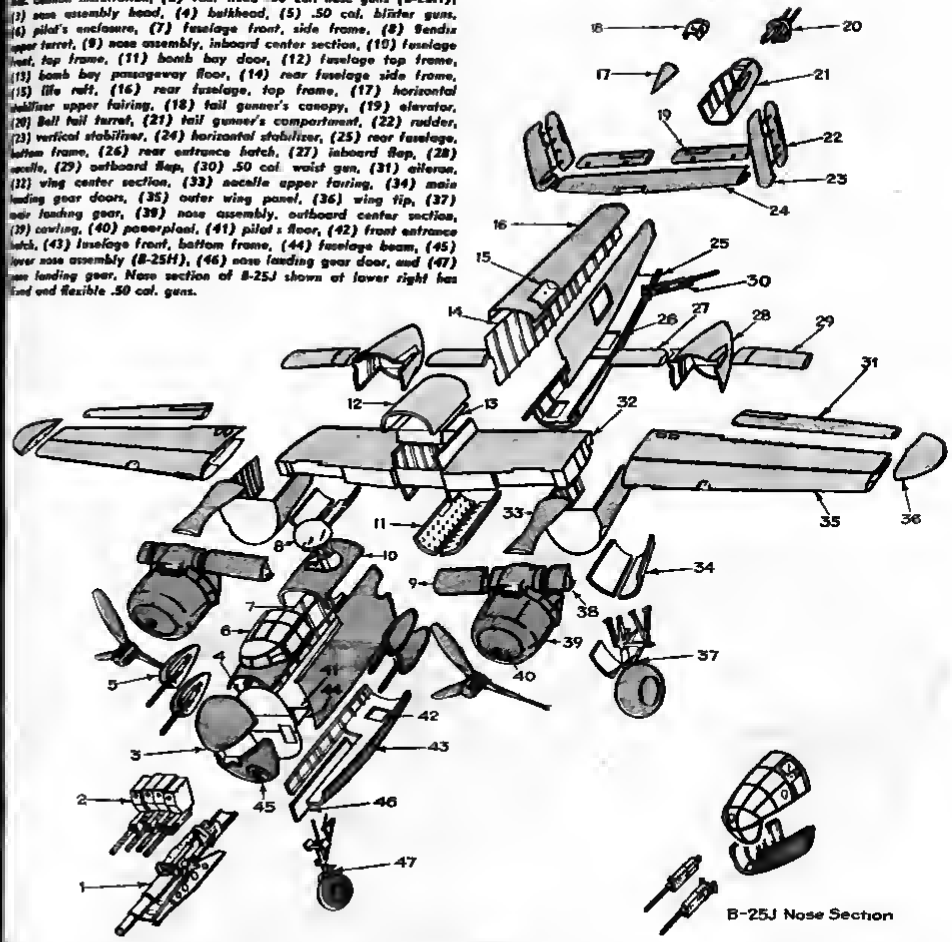
Nose of the B-25H is fitted with four machine guns and a 75 mm cannon, the B-25J with two machine guns—one flexible and one fixed—protruding from the bombardier's enclosure.

Tactical purpose of the B-25H is primarily for low level attack and the destruction of land or naval materiel targets, in support of ground, air, and naval forces. As a dual purpose plane, it can knock out surface forces protect-



Three-view aspect of North American B-25J Mitchell medium bomber. B-25H, with all-metal nose and 75 mm. cannon, has dimensions identical to those shown above except that distance between centerlines of nose wheel and main landing wheels is 2 in. greater and over-all length is 2 ft.-2 in. less.

Exploded view showing details of B-25H and B-25J. Legend: (1) 75 mm. cannon installation, (2) four fixed .50 cal. nose guns (B-25H), (3) nose assembly head, (4) bulkhead, (5) .50 cal. blister guns, (6) pilot's enclosure, (7) fuselage front, side frame, (8) Bendix upper turret, (9) nose assembly, inboard center section, (10) fuselage front, top frame, (11) bomb bay door, (12) fuselage top frame, (13) bomb bay passageway floor, (14) rear fuselage side frame, (15) life raft, (16) rear fuselage, top frame, (17) horizontal stabilizer upper fairing, (18) tail gunner's canopy, (19) elevator, (20) Bell tail turret, (21) tail gunner's compartment, (22) rudder, (23) vertical stabilizer, (24) horizontal stabilizer, (25) rear fuselage, bottom frame, (26) rear entrance hatch, (27) inboard flap, (28) nacelle, (29) outboard flap, (30) .50 cal. waist gun, (31) aileron, (32) wing center section, (33) nacelle upper fairing, (34) main landing gear doors, (35) outer wing panel, (36) wing tip, (37) main landing gear, (38) nose assembly, outboard center section, (39) cowling, (40) powerplant, (41) pilot's floor, (42) front entrance hatch, (43) fuselage front, bottom frame, (44) fuselage beam, (45) lower nose assembly (B-25H), (46) nose landing gear door, and (47) nose landing gear. Nose section of B-25J shown at lower right has fixed and flexible .50 cal. guns.



B-25J Nose Section

ing the target, then proceed to bomb the target from low altitudes. The B-25J is primarily a medium bomber, nevertheless capable of dealing with surface forces.

In spite of their versatility, current B-25's basically remain unchanged from the original. They are semi-monocoque mid-wing monoplanes powered with two Wright 1700-hp. 14-cyl. engines. All fixed surfaces are metal-covered. Flight control surfaces, inclusive of wing flaps, are heavily doped-fabric covered members. Countersunk rivets are used on the forward one-third of fuselage skin and fixed surfaces to reduce drag, and brazier head rivets on the aft two-thirds.

Fundamental Design Information

	B-25H	B-25J
Overall length (max.)	51' 3.75"	53' 5.75"
Height (max.)	16' 4¼"	Same
Span	67' 6.704"	Same
Wing area (less ailerons)	577.67 sq. ft.	Same
Length of root chord	154.6080"	Same
Length of tip chord	64.257"	Same
Fuselage depth (max.)	7' 4"	Same
Fuselage width (max.)	4' 8.5"	Same
Load factor (ultimate)	5.5	Same
Normal gross weight	28 330 lb.	27 000 lb.

Normal entrances and exits consist of two hatches in the plane's belly, one under the upper turret compartment, the other aft of the waist gunner's position. Automatically retracting stepladders are provided.

Escape hatches are for use in crash landings when main entrance hatches are blocked, or under emergency conditions while the airplane is in flight.

Crew for the B-25H consists of a

pilot, upper turret gunner, cannoneer-navigator, waist gunner, and tail gunner. Pilot, co-pilot-navigator, bombardier, upper turret gunner, waist gunner, and tail gunner man the B-25J.

Both bombers now carry considerably more armor plate to afford maximum protection for the crew and vital equipment. Provided also, is a rubber lifeboat, emergency equipment, pyrotechnics, and the usual oxygen equipment.

Center Section Structure

Backbone of the B-25 is the bomb bay section, built integrally with the wing center section. To resist a major portion of fuselage bending loads carried by this section, 24ST H-shaped extruded lower longerons and Z-shaped upper longerons are employed. Fore and aft fuselage frames, to which longerons attach, are composed of 24ST webs riveted to right-angle alloy extrusions. These frames are attached to front and rear wing spars and serve to introduce flight loads into the fuselage.

Intermediate similarly constructed frames serve as attaching members for the bomb rack structure which is stressed to carry part of the fuselage loads. Top fuselage frames in this section support bomb hoisting loads.

Sides of the bomb bay compartment are additionally supported by intermediate frames, plate ribs, rolled Alclad stringers, and channels. Bomb rack rails which support bomb loads are bolted to bomb rack attachment frames. Roof of this compartment also serves as the floor of a crawlway which permits crew travel fore and aft during flight. This floor is .032 24ST Alclad stiffened by hat-shaped rolled angles and extrusions. Transverse shear loads are borne by the floor along with the top fuselage skin. At this section the fuselage is skinned with lap-jointed 24ST Alclad varying from .032 on top to .051 on the sides.

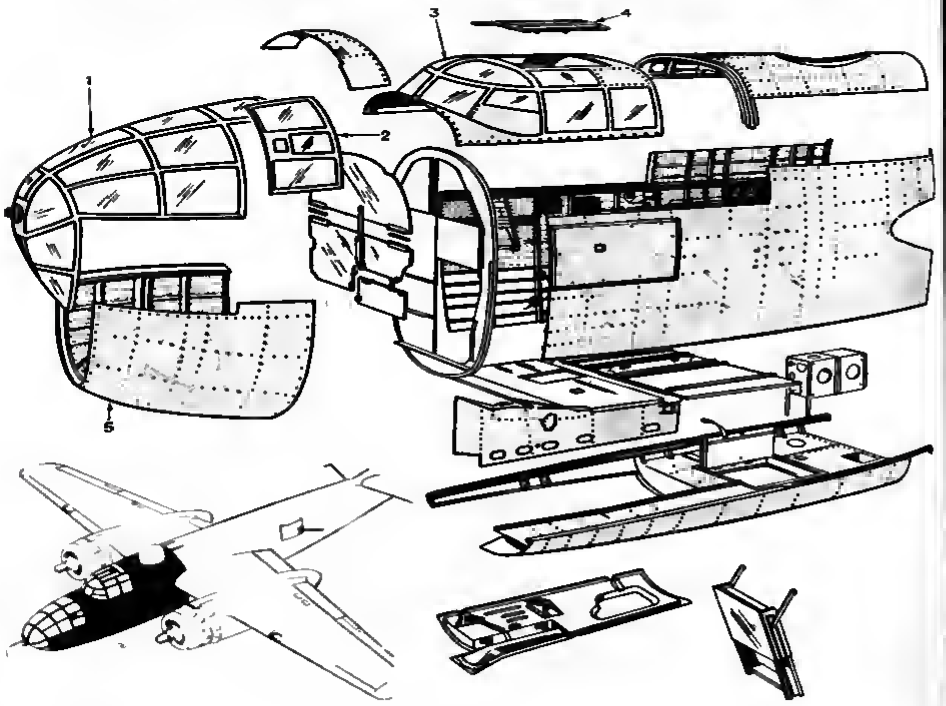
Bomb bay doors have inner and outer skins. Inner skin is a single panel lightened by circular cutouts, attached to a framework of stringers and frames. Outer skin is riveted to and supported by the same framework. Doors are hinged to the adjoining structure at three points.

Wing Center Section

The wing center section is attached to and supported by the intermediate fuselage section or bomb bay compartment. Two main spars, front and rear, serve to resist spanwise bending loads and extend 157 in. on either side of fuselage centerline.

Spars consist of 24ST aluminum alloy webs, .081, .064, and .051, to which extruded capstrips are riveted. A firewall of .019 stainless steel acts

B-25J front fuselage frame assembly: (1 and 2) Bombardier's enclosure and escape hatch, respectively, (3 and 4) pilot's compartment enclosure and escape hatch, respectively, and (5) fuselage front lower assembly



a doubler and extends along the forward side of the front spar web between the engines. Extruded stiffeners are bolted and riveted between the capstrips strengthen the webs.

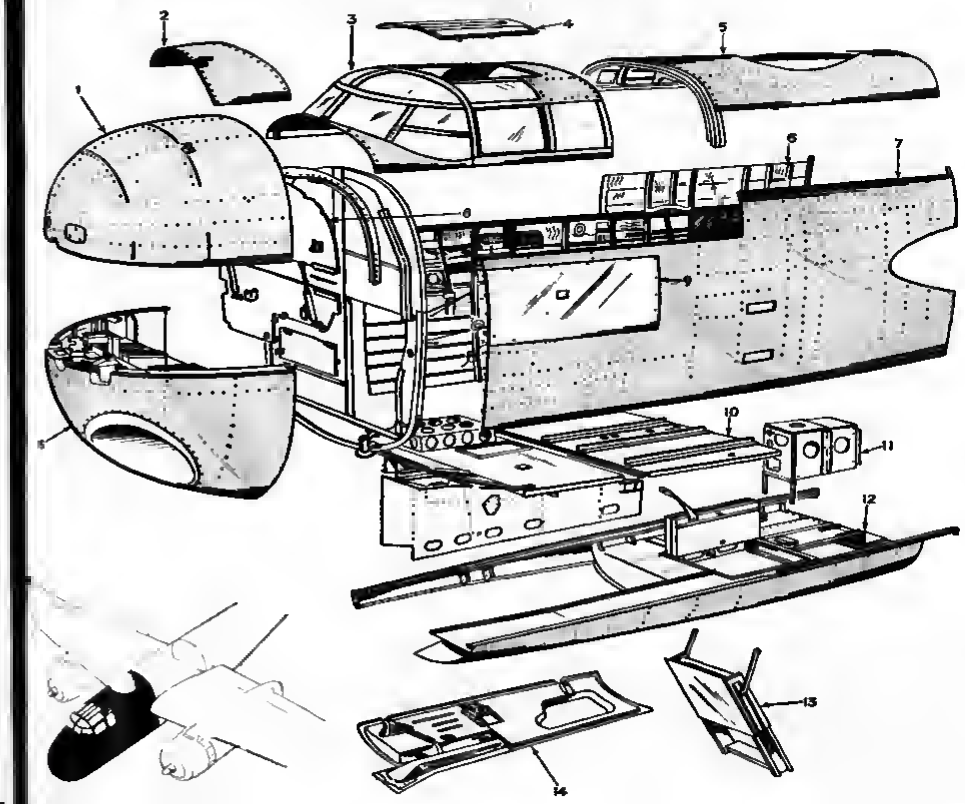
Landing gear beams between front and rear spars begin at a point 97 in. from fuselage centerline, and consist of .051 24ST Alclad webs and vertical 24ST extruded stiffeners. Attached to the lower part of landing gear beams are gear lock fittings and vertical brace fittings. Vertical load on these fittings is applied to the web by means of adjacent vertical stiffeners. Purpose of the landing gear beam is to resist vertical loads when landing and while the plane is supported on the ground by means of the landing gear.

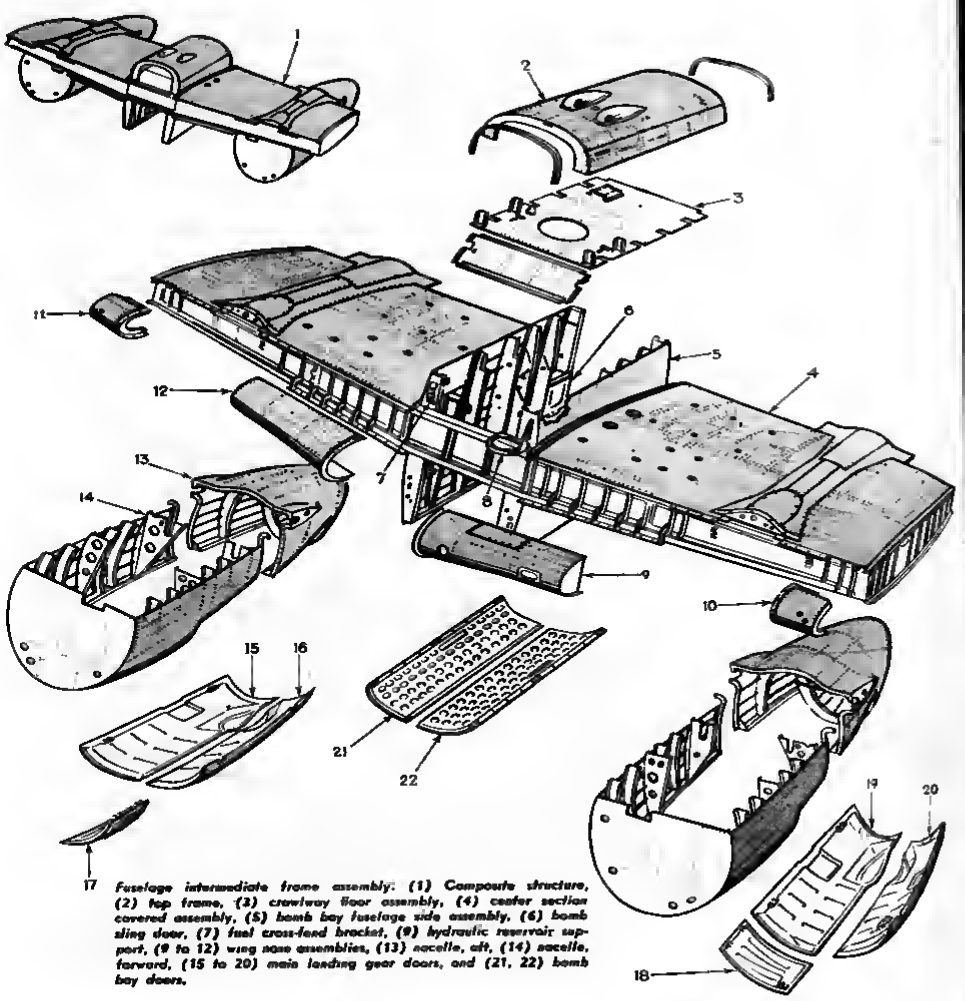
An intermediate beam, known as the gas web, is located between front and rear spars and extends outward from the fuselage for a distance of 97 in. on each side. This member separates the two main fuel compartments and carries some of the flight loads. It consists of an .081 24ST Alclad web and 24ST hat-shaped stiffeners riveted at 10 in. intervals.

Six center section ribs distribute a major portion of landing gear fitting, landing gear beam, and engine mount fitting loads. Wing joint plate-type ribs at each end of the center section serve to redistribute the normal shear and torsional moment from outer panel to center section. They are formed principally of .064 24ST Alclad, and are supported vertically by stiffeners. Similar ribs placed 97 and 133 in. from either side of fuselage centerline are made, respectively, of .064 and .091 24ST Alclad and aid in distributing landing gear and engine mount fitting loads.

Upper center section surface is skinned with 24ST Alclad from .032 to .081 thick, riveted to ribs and transverse stiffeners, butt-jointed spanwise and lap-jointed chordwise. Lower center section surface is fitted with .051 and .064 24ST panels, removable to provide access to fuel cells located in the wing. Panels are stif-

B-25H front fuselage frame assembly: (1) Hand, (2) cowling, (3 and 4) pilot's enclosure and escape hatch, respectively (5) fuselage top, turret gunner's compartment, (6, 7) fuselage front side assemblies, (8) armor plate floor, (9) deflector plate, (10) pilot's floor, (11) turret structure support, (12) fuselage front bottom assembly, (13) front entrance hatch cover and ladder assembly (14) nose wheel door, and (15) lower nose assembly.





Fuselage intermediate frame assembly: (1) Composite structure, (2) top frame, (3) crawlway floor assembly, (4) center section covered assembly, (5) bomb bay fuselage side assembly, (6) bomb sling door, (7) fuel cross-feed bracket, (9) hydraulic reservoir support, (9 to 12) wing nose assemblies, (13) nacelle, aft, (14) nacelle, forward, (15 to 20) main landing gear doors, and (21, 22) bomb bay doors.

fened chordwise by hat-sectioned formers and by spanwise stringers. Fuel tank securing fittings are attached to inner surface of the panels

Center section leading edge is conventionally construced of rolled 24ST Alclad skin stiffened by stringers and supported by formed nose ribs. Inboard flaps constitute the center section trailing edge.

Fuselage Forward Section

Forward fuselage section extends aft from the nose to the bulkhead at front end of the bomb bay. This section consists of the hinged hood and fixed lower "front" section on the B-25H, or bombardier's compartment on the B-25J, and pilot and upper turret compartments on both models.

Main bulkhead for support of nose gear fittings and pilot's compartment armor plate fittings, is located at rear of front section.

Pilot's cockpit enclosure is made of Lucite or Plexiglas, and glass sheet, set in metal frames and sliding panels Floor section is an integral structural feature of the fuselage The 75 mm. cannon on the B-25H is in the crawl

Wing Data

	B-25H	B-25J
Airfoil section (root)	NACA 23017	Same
Airfoil section (tip)	NACA 4409R	Same
Area including ailerons and flaps	609.8 sq ft	Same
Aspect ratio	7.48	Same
Chord, root	154.600"	Same
Chord, tip	64.257"	Same
Mean aerodynamic chord length	116.16"	Same
Sweepback, leading edge	4° 12' 15"	Same
Taper ratio	.415	Same
Incidence, root	3° 0' 23"	Same
Incidence, tip	0° 30' 0"	Same
Dihedral (L.E.), center section	4° 38' 23"	Same
Dihedral (L.E.), outer panel	0° 21' 39"	Same
Maximum rib spacing, center section	20"	Same
Maximum rib spacing, outer panel	16"	Same
Spar webs or spar locations		
Center section, front	15.52% of root chord.	Same
Center section, rear	67.27% of root chord.	Same
Center panel	33% of root chord	Same

way used by the bombardier on the B-25J. The cannon housing is on the left side of pilot's compartment under the cockpit floor, and serves, structurally, as a torque-box.

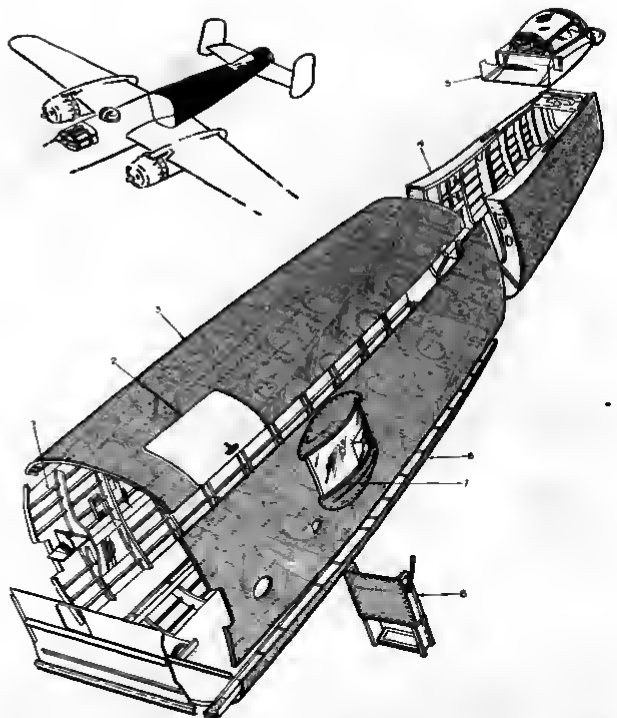
Cannoneer's compartment on the B-25H is known as the upper turret compartment on the B-25J, and is located behind pilot's enclosure. It includes the front entrance hatch, upper turret guns, and on the B-25H is used as the loading station for the cannon.

Four longerons are the largest single load-carrying fuselage members, and bear axial tension and compression forces due to action of bending. Shape and size of each depends on the load carried, and except for the extruded longerons in the bomb bay assembly, they consist of channels formed from 24SO Alclad sheet later heat treated to 24ST.

Two lower longerons extend the full length of the fuselage. They are continuous within individual fuselage sections later bolted together to form a running fuselage structure. In the fixed portion of the front forward section, the left longeron (on B-25H and J) is a Z-shaped member formed of .051 Alclad (later heat treated). Because of higher load factors, thickness of the corresponding right lower longeron is increased to .091.

From the front forward section extending back through pilot's compartment to front bulkhead of the bomb bay section, lower longerons are downward-flanged .064 24ST Alclad channel members, reinforced along the skin side flange by extruded angle. In approximately the middle of pilot's compartment an .081 rear section is spliced in with a .064 doubler of the same material

The upper longerons in the forward section are located only between the bomb bay and pilot's compartment



Fuselage rear frame assembly: (1) Side frame assembly, (2) life raft door, (3) top assembly, (4 and 5) tail gunner's compartment and canopy, respectively, (6) bottom assembly, (7) waist gun window, and (9) rear exit hatch.

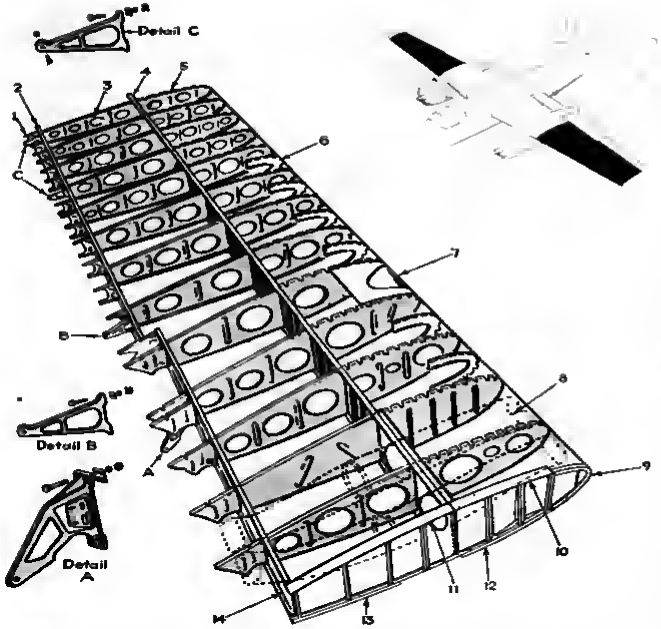
rear bulkhead and are .091 24SO formed channels heat treated to 24ST They are otherwise replaced by members known as bombardier's rails and pilot's rails, and serve as upper extensions of the longerons "Breaking" of the upper longerons and continuation of the structural frame on a lower plane is made necessary by the cutout for the glass enclosure in pilot's compartment.

Each pilot's rail runs longitudinally along the side of the fuselage, just below pilot's side window. Rails are attached to the fuselage finishing angle at the end of the gun turret compartment, extend forward, and are connected to the front bulkhead of pilot's compartment. Each is a downward-flanged L-shaped channel member of .091 24SO Alclad sheet (later heat treated) to which an extruded angle is riveted Forward and aft of a bulkhead located approximately at the first frame of pilot's enclosure, loads diminish in intensity and the downward flange of the extruded angle is machine tapered.

Pilot's compartment glass enclosure frame is secured by wing channel nuts riveted to the inner flange of pilot's rail.

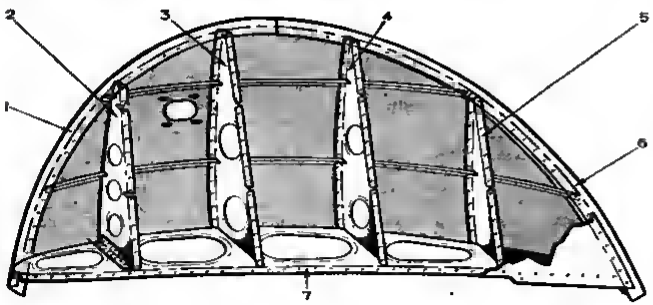
Second forward extension of upper longerons is provided by bombardier's rails which extend on each side of the fuselage from a bulkhead in line with first pilot's enclosure frame to the front of the forward front nose section on the B-25H.

On the B-25J, these rails constitute the base of bombardier's transparent enclosure, serve as the main structural members of the nose section, and are on a lower plane than pilot's rails From the front bulkhead of pilot's compartment forward, they are downward-flanged .051 24SO Alclad channel members (heat treated to 24ST after



Details of outer wing panel structure. (1) Trailing edge rib, (2) aileron false spar, (3) intermediate rib, (4) main spar, (5) nose rib, (6) former, (7) landing light, (8) oil temperature regulator location, (9) bolting angle, (10 to 13) bolting angle supports and attaching joints, and (14) flap false spar. Detail (A) shows features of flap hinge bracket, and details (B) and (C) represent aileron outboard and inboard hinge brackets.

Structural features of wing tip. (1) Forward bow, (2) front former, (3 and 4) front and rear intermediate formers, respectively, (5) rear former, (6) rear bow, and (7) rib.



Balance Factors

	B-25H	B-25J
Gross weight c.g. location, wheels up Aft L.E. M.A.C.	23.2%	25.3%
Gross weight c.g. location, wheels down Aft. L.E. M.A.C.	21.2%	23.4%
Extreme forward position of c.g. possible in flight: Aft L.E. M.A.C.	14.1%	17.3%
Extreme rearward position of c.g. possible in flight: Aft L.E. M.A.C.	28.8%	32.8%

forming) and are .064 thick, rearward. Except for armor plate, fuselage is skinned with 24ST Alclad ranging from .051 to .025.

Rear fuselage section includes that portion aft of the bomb bay compartment. Upper longerons are flanged channel sections of formed and subsequently heat treated 24SO Alclad sheet, diminishing in thickness from .091 to .051 at the tail.

Lower longerons are broken at the waist gun position and consist of two U-channels of .081 24ST Alclad riveted together to form an H-section. They are reinforced along the inside flanges by a .091 24ST Alclad doubler riveted to upper and and lower flanges of the two U-sections. An additional doubler angle of .091 24ST Alclad is riveted to the bottom inboard side of the lower U-section for a distance of 12 in. immediately aft of the bomb bay rear bulkhead. Lower longerons aft of the waist gun positions are channels formed of sheet Alclad of diminishing thickness.

Rear fuselage skin is 24ST varying from .064 to .032, depending on stresses involved, and is riveted to fuselage stringers and formers in the usual manner.

Fuselage frames are formed from sheet Alclad varying from .032 to .064 depending on local stress or use to which they are to be put as supports for attachment of miscellaneous equipment. Except for a few frames located at points of particular stress or those used in attachment of the various fuselage sections, they are open channels or angles provided with stringer cutouts, and in some cases with holes for passage of cables, conduits, or plumbing lines.

Specially stressed frames, or bulkheads, are located at the end of the front forward section where the nose landing gear fittings are attached; two frames in the bomb bay compartment where bomb racks are installed; two at points of attachment of horizontal stabilizer to fuselage, and two which carry lift loads from the wing into the fuselage sides at the point where front and rear wing spars pass through the center section. These frames are generally a web of sheet metal reinforced by extruded capstrips

riveted around the web permeter. Stringers used in the B-25H and J fuselages are rolled sections of 24ST Alclad except for a few extruded shapes of 24ST.

Fixed Surfaces

Each outer wing panel is assembled about a main spar located at the 33 percent chord line. Secondary false spars extend the length of the panel along its trailing edge. Remaining structure consists of ribs pressed from 24SO and 24ST Alclad sheet, extruded spanwise stringers and 24ST Alclad skin. Access and inspection doors are provided along the entire wing, most being on the lower skin.

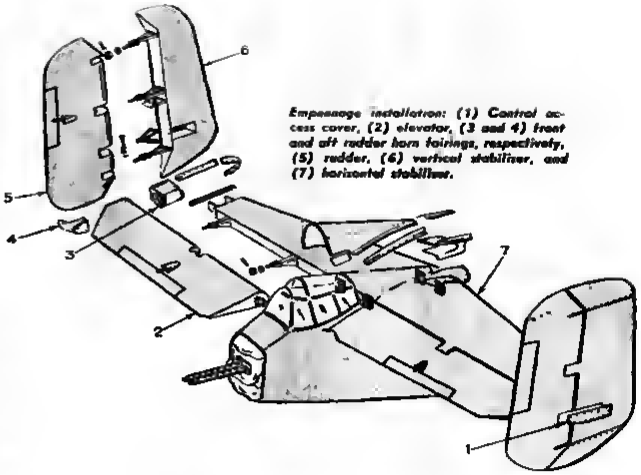
Outer main wing spar consists of inboard and outboard sections of 24ST sheet spliced with a .064 Alclad doubler plate. Inboard spar section is .081 material formed with upper and lower U-shaped flanges serving as spar caps. The web is stiffened by vertical rib attaching right-angle extrusions and independent stiffener angles.

Outboard of the wing center section attaching plates, the web is cut away to permit installation of two oil cooling ducts. Each cutout is reinformed by a T-section extruded ring riveted around the cutout. Inboard spar section is additionally reinforced by an .081 24ST Alclad doubler extending between the ribs on either side of the cutout. The outboard flanged web is .064 Alclad with upper and lower edges formed to provide spar caps. Eight flanged lightening holes are provided in the spar tip.

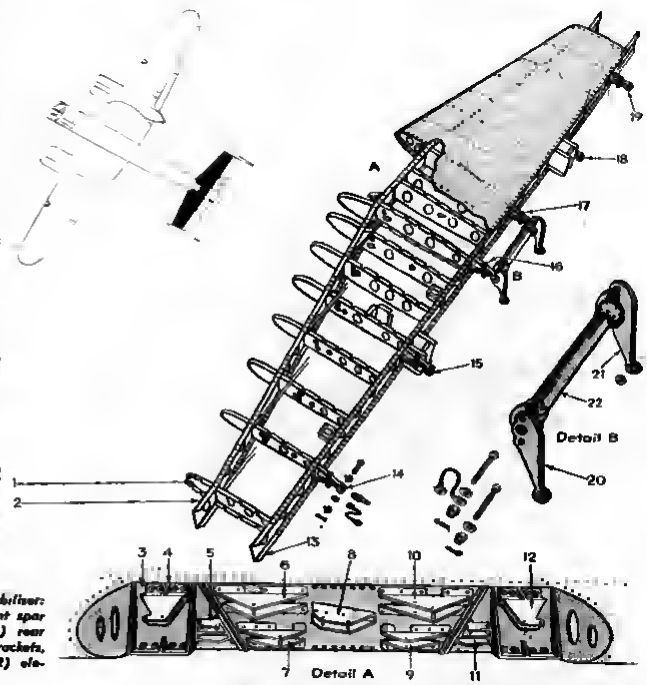
The outer wing flap false spar is .040 24ST Alclad with formed right-angle flanges for spar caps. Between the endplate and the third rib, the spar of a single sheet of .040 24ST section riveted to upper and lower spar caps. Inboard web section has several cutouts to accommodate equipment.

Ailerons are supported by a false spar of a single sheet of .040 24 ST Alclad. Formed right-angle flanges on the upper and lower edges provide spar caps. The web is stiffened by several rib attaching angles of extruded alloy arranged vertically along the solid web.

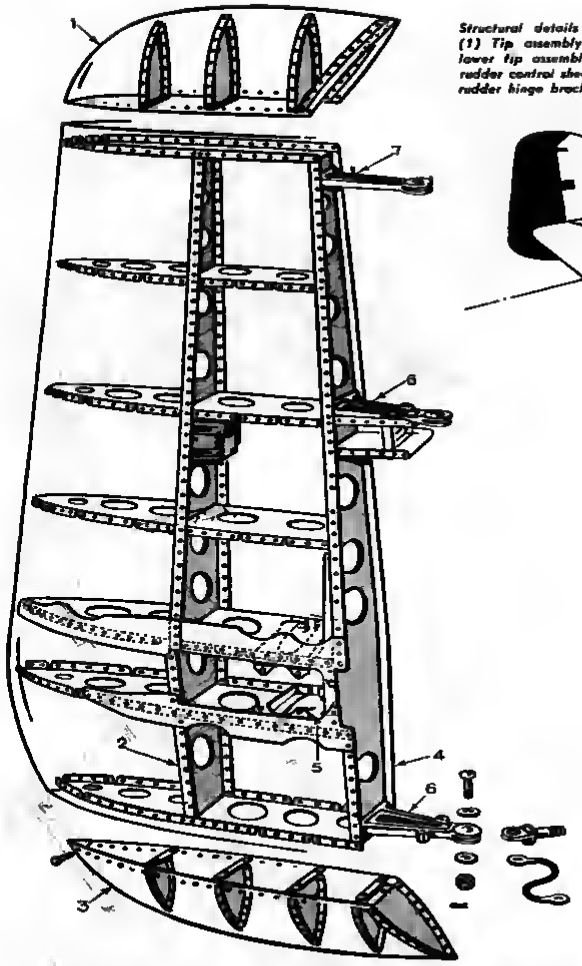
Majority of the wing ribs are pressed from 24ST or 24SO Alclad varying from .025 to .040. All ribs forward of the main spar are provided with flanges riveted to the skin. Most intermediate ribs between main



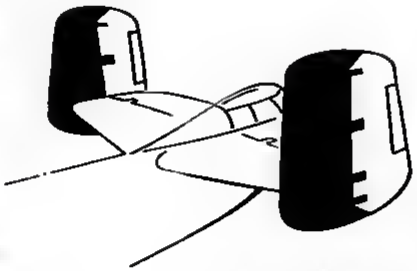
Empennage installation: (1) Control access cover, (2) elevator, (3 and 4) front and aft rudder horn fairings, respectively, (5) rudder, (6) vertical stabilizer, and (7) horizontal stabilizer.



Structural details of horizontal stabilizer: (1) Rib, (2) front spar, (3) front spar fitting, (4 to 12) brackets, (13) rear spar, (14 to 19) elevator hinge brackets, (20, 21) elevator horns, and (22) elevator connecting tube.



Structural details of vertical stabilizer. (1) Tip assembly, (2) front spar, (3) lower tip assembly, (4) rear spar, (5) rudder control sheave support, and (6, 7) rudder hinge brackets.



spar and false spars are formed so they do not contact the skin but are attached to stringers by means of clips. All ribs are provided with conventional lightening holes and stiffening beads.

Wingtips are constructed of three ribs and several formers, all press-formed from Alclad sheet stock. Beaded lightening holes, stringer cut-outs, and flanges are provided in each member. Contour skin is formed from 24SO and tips are covered with 24ST Alclad and attached to the wing with screws.

Horizontal stabilizer is a full cantilever stressed skin structure of pressed ribs, spanwise stiffeners, and two spars. Front stabilizer spar is a web of .051 24ST Alclad spliced to a heavier web of .064 material where it covers the fuselage. Beaded lightening holes and angle vertical members stiffen the web. Top and bottom capstrips are extruded angles riveted into place. Rear spar is of substantially the same construction except that the web is .051 throughout.

All ribs are made of .032 24ST Alclad with flanges acting as caps and stiffening beads pressed in forming. Lightening holes and stringer cutouts are also provided. Stringers are extruded 24ST bulb angles and formed J-sections. Stabilizer skin is .025 and .032 24ST Alclad riveted to the framework.

Vertical stabilizers are similar in structure and are attached to the horizontal stabilizer with standard AN bolts at the junction point of front and rear spars.

Movable Surfaces

Wing flaps of the B-25H and J are the trailing edge slotted type, consisting of two sections on each side of the fuselage. Inboard flaps extend from the nacelle tail cone to the side of the fuselage, and outboard flaps extend from the aileron to the nacelle cone. When in neutral position, flaps are sealed by a non-metallic strip attached to the upper wing surface, and large slot openings on the lower surface of the wing are closed by small fairing doors.

When flaps are moved to a down position, fairing doors swing upward permitting flow of air up between the fixed wing and the lowered flap. Rubbing strips of .010 half-hard steel sheet are provided along the flap leading edge at two places. Actuating torque of each flap is taken by a torque tube which extends into its interior. Flaps are supported by, but not hinged to the torque tube.

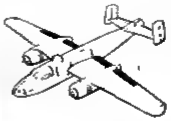
Flaps have power-pressed ribs and spanwise stiffeners. Ribs are provided with stringer cutouts and lightening holes. Trailing edge is formed of .032 24ST Alclad.

Sealed type ailerons have a front spar and pressed ribs. Conventional weights are attached to the leading edge to obtain static and dynamic balance.

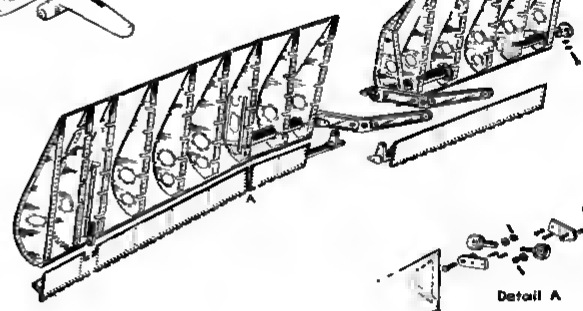
Aileron main spar is 137 in. and is formed from .032 24ST Alclad sheet into a U-shaped channel, joggled on the outside upper and lower cap edges to provide for attachment of fabric replacement strips. Rib attaching angles are placed vertically on the spar web. Lightening holes are spaced along its entire length. A light false spar is provided as a trim tab attaching member. Ribs are formed from .032 24ST Alclad and include formed top and bottom frames and beaded lightening holes.

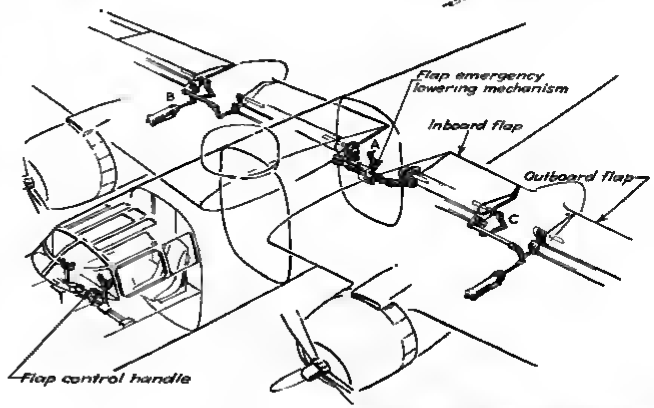
A trim tab, mounted in the trailing edge of each aileron, consists of a small metal airfoil, of rectangular plan view, having a U-shaped spar, triangular shaped ribs, and an Alclad covering. Hinged at three points to the aileron false spar, the tabs serve as control boosters in addition to trim units and are not balanced.

Both elevator and rudder spars are formed of .040 24ST Alclad with ⅜ in. flanges along top and bottom surfaces. Flanged holes lighten the structure and stiffen the spar web. Rudder and elevator false spars are U-shaped, formed from .032 24ST Alclad. Trailing edge ribs attach to these members, and brackets are used to attach trim tabs at three points along the flat surface of the spar. Nose skins for both members are rolled from .025 24ST Alclad and are riveted to main



Structural details of outboard and inboard wing flaps. Detail A shows features of fairing door assembly.



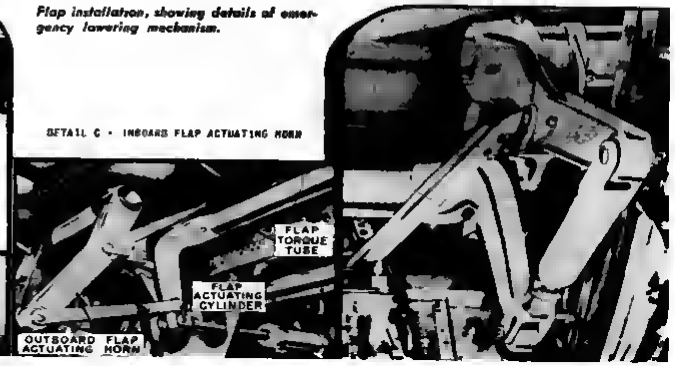


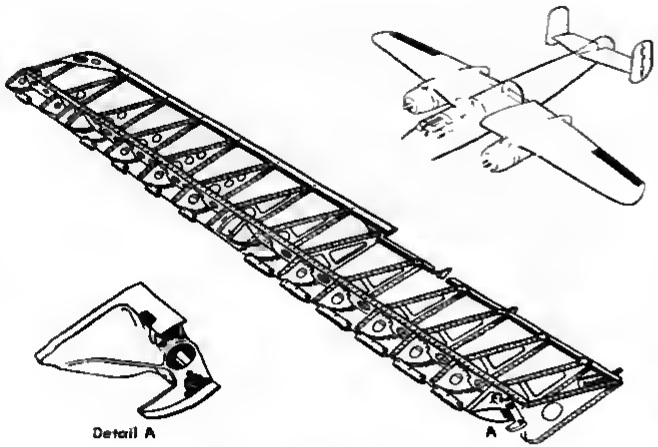
DETAIL B - FLAP ACTUATING MECHANISM

DETAIL A - EMERGENCY LOWERING CRANK

Flap installation, showing details of emergency lowering mechanism.

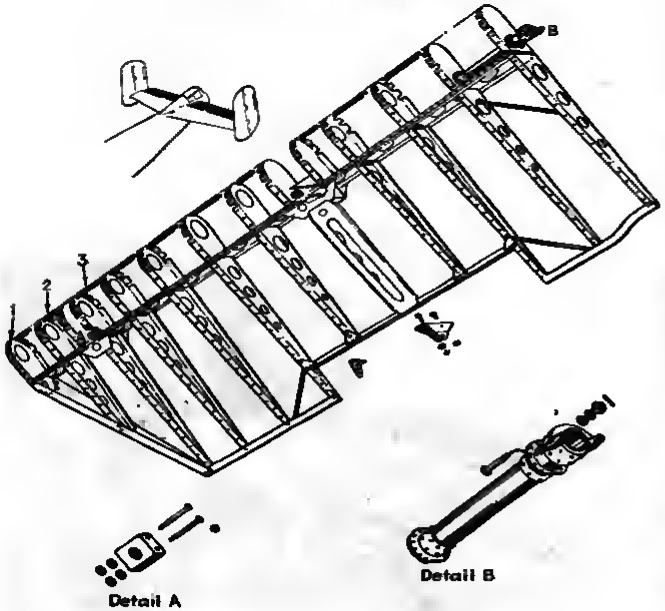
DETAIL C - INBOARD FLAP ACTUATING HORN





Aileron frame assembly. Detail A shows inboard hinge bracket with heavy-duty bearing.

Elevator frame assembly (1) Rib, and (2 and 3) short and long counterbalance weights, respectively.



spar flanges and rib caps. Rudder nose skins are provided with flanged lightening holes. Rudder and elevator trailing edges are U-shaped members of .025 Alclad riveted to the rib tips. Trim tabs are constructed of sheet metal in the conventional manner.

Fabric covering of the elevators and rudders is grade A mercerized cotton, doped and finished. Covering is attached to dimpled holes in the trailing edge rib catstrips by countersunk sheet metal screws inserted through dimpled washers. Doped reinforcing tape is placed along the ribs before the screws are inserted. After insertion of the screws and washers, a strip of finishing tape is placed over them to provide a smooth surface.

Nacelles and Engine Mount

Engine nacelles are broken down into three main divisions—engine cowling section, front section, and rear section. Engine cowling section consists of a nose ring, cowl formers, and cowl panels. Material is aluminum alloy and corrosion resistant steel. Front and rear sections are of conventional construction and are composed of longerons, frames, stringers, and skin. The entire structure is supported by the front section frames bolted to the bottom of the wing center section.

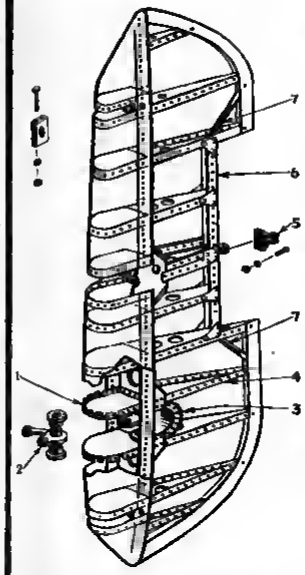
Nacelle front and rear longerons are rolled Z-section members .091 and 064 24SO Alclad, respectively, heat treated to ST condition after forming. Frames are typical pressed members of 24ST Alclad of varying thickness and have right-angle flanges and stiffening beads for added strength.

The firewall web is made of stainless steel sheet, spotwelded to a series of stiffening members of varying size and cross section. Holes are provided to accommodate electrical and hydraulic lines.

The engine mount is X4130 chrome molybdenum steel tubing, arc welded into a single unit, bolted to the wing structure at four points. The engine is attached to the mounting ring by cushioned dynamic fittings. Tube diameters range from 1¼ to 2 in. O. D with wall thickness varying from 049 to 094.

The B-25 was the first production medium bomber type to incorporate the now widely used tricycle landing gear.

Main landing gear is of the single-leg, half-fork, full-cantilever design and is fully retractable into the engine nacelles. Each shock strut consists of a cylinder and piston, shock being absorbed by air and oil. Piston and cylinder are interconnected by forged chrome molybdenum steel torsion links which transmit torsional moments from piston to cylinder. Torsional loads



Rudder frame assembly: (1) Typical nose rib, (2) torque tube, (3) horn cutout fabric support, (4) typical trailing rib, (5) tab bracket, (6) false spar, and (7) false spar reinforcing tubes.

applied during landing are transmitted through the shock strut to the side thrust brace, two trunnions, the downlock, and the main supports.

A 47-in. tire is mounted on each of two cast aluminum alloy drop-center-type wheels carried on hardened steel axles over which are pinned chrome molybdenum steel forks. All chrome molybdenum steel landing gear parts are heat treated to a tensile strength of 160 000—180,000 lb./sq. in. Each wheel of main landing gear is equipped with hydraulically operated, multiple-disk metal-to-metal clutch type brakes.

Nose landing gear consists of an air-oil shock strut and 30-in. wheel. Like the main landing gear, the nose gear is fully retractable. In retracted position it rests in the fuselage underneath and to the right of the pilot. All torsion and landing loads are transmitted and reacted in the same manner as they are in the main gear. The nose wheel has a steering range of 60 deg. left or right, allowing a turn with either main gear as a pivot point. A hydraulic shimmy damper is mounted on the strut which also incorporates a self-centering device to center the wheel when the weight of the plane is removed from the nose gear.

Nose ring and removable cowling: (1) Engine nose ring, (2) link, cowling to engine, (3) cowl former, (4) engine flap ring and (5) removable cowl panel.

Hydraulic System

The hydraulic system—single-pressure type—operates the tricycle landing gear, wing flaps, cowl flaps, bomb bay doors, and brakes. Cowl flaps have separate control handles for left and right engines, and operation of either the cowl or wing flap may be stopped at any desired position. A manually operated emergency hydraulic system permits actuation of the different sub-systems should both engine-driven pumps fail, or when the airplane is on the ground with engines not operating.

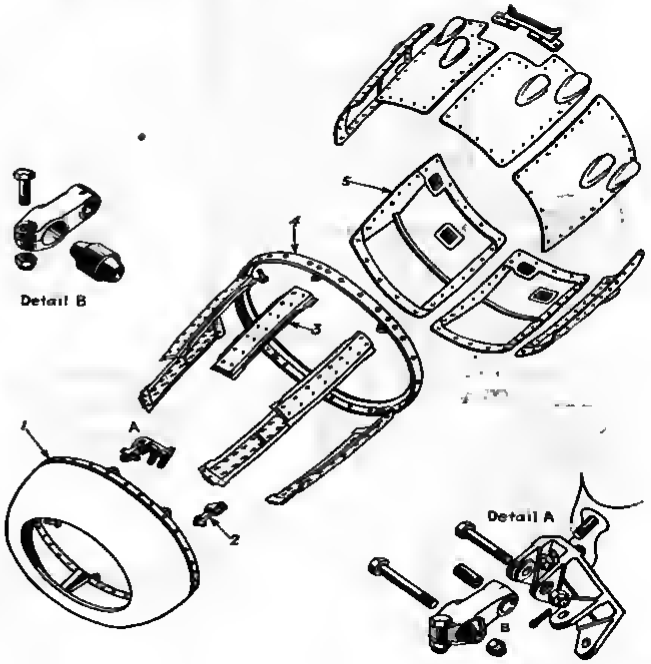
The Pesco 349P hydraulic pumps are engine-driven, two-gear, positive displacement types with a pressure limit of 1,500 lb./sq. in. for continuous operation, will operate in either direction, and are completely lubricated by the fluid passing through. They are located on the engine accessory sections and either is capable of providing sufficient pressure for the system.

Fluid from the reservoir is forced from the pumps through lines routed back to the forward wall of the bomb bay where the lines from both pumps join. Check valves are provided so that failure or one pump will not render ineffective the pressure produced by the operating pump. The pressure line continues on from a T-fitting through a check valve and then through all the system lines leading to the selective operating systems.

Fuel System

An independent fuel system is provided for each engine. Main source of fuel supply is from four self-sealing tanks, two located in each wing center section between the tuselage and the engine nacelle. Front and rear tanks on each side are connected by a line from the rear tank to an adapter to which a booster pump is attached. A check valve permits fuel to flow from the rear to the front tank and then to the engine, but prevents fuel from returning to the rear tank.

Booster pumps are operated by



switches on pilot's control pedestal switch panel. An auxiliary fuel supply is also obtained from six small self-sealing tanks, three in each wing center section outboard of the main tanks. Front and outboard tanks in each group are connected with the rear auxiliary tank by a line from each tank aft through the nacelle to an electrically operated transfer pump. The transfer pump draws fuel simultaneously from the three auxiliary tanks, pumps it through a line to the front main tanks.

Each engine is fitted with type G-9 rotary vane positive displacement type fuel pump located on the right-hand aft end of the engine.

Oil System

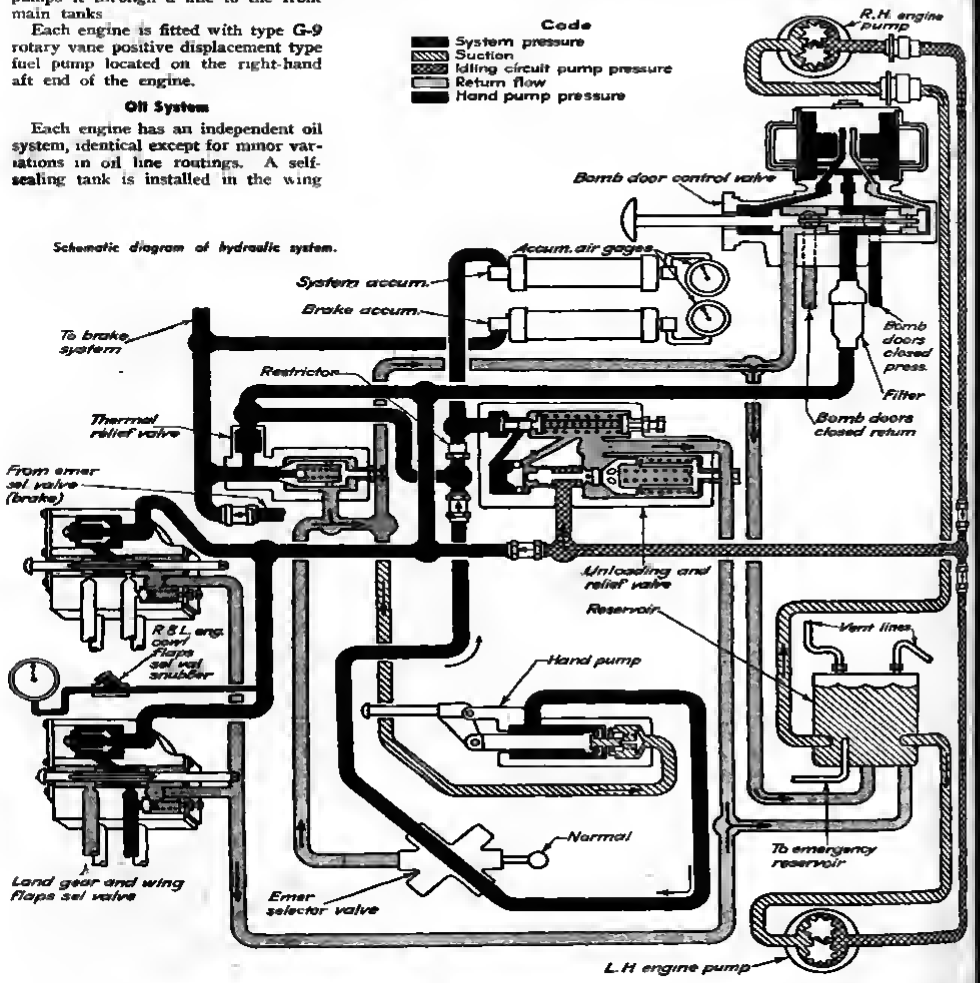
Each engine has an independent oil system, identical except for minor variations in oil line routings. A self-sealing tank is installed in the wing section aft of the engine firewall. Oil flows from the tank to the engine-driven oil pump, to the engine under pressure of 80-90 lb./sq. in.

System oil is utilized for feathering the propellers and is taken from the circulating oil by a pump, mounted on the firewall, which delivers the oil under pressure to the propeller governor mounted on the front of the engine. Temperature of the oil returning from the engine is regulated by two thermostatically controlled type C-8 oil temperature regulators mounted in the center portion of ducts which open at the leading edge of the wing and have outlets through the upper surface of the wing just forward of the wing flaps.

Surface Control System

A duplicate cable control system is installed to actuate rudders, elevators, and ailerons. Each system is so de-

Schematic diagram of hydraulic system.



signed that loss, through gunfire, of any one cable will not seriously cripple the plane. Cables are color-banded to facilitate assembly, repair, and inspection of the control system.

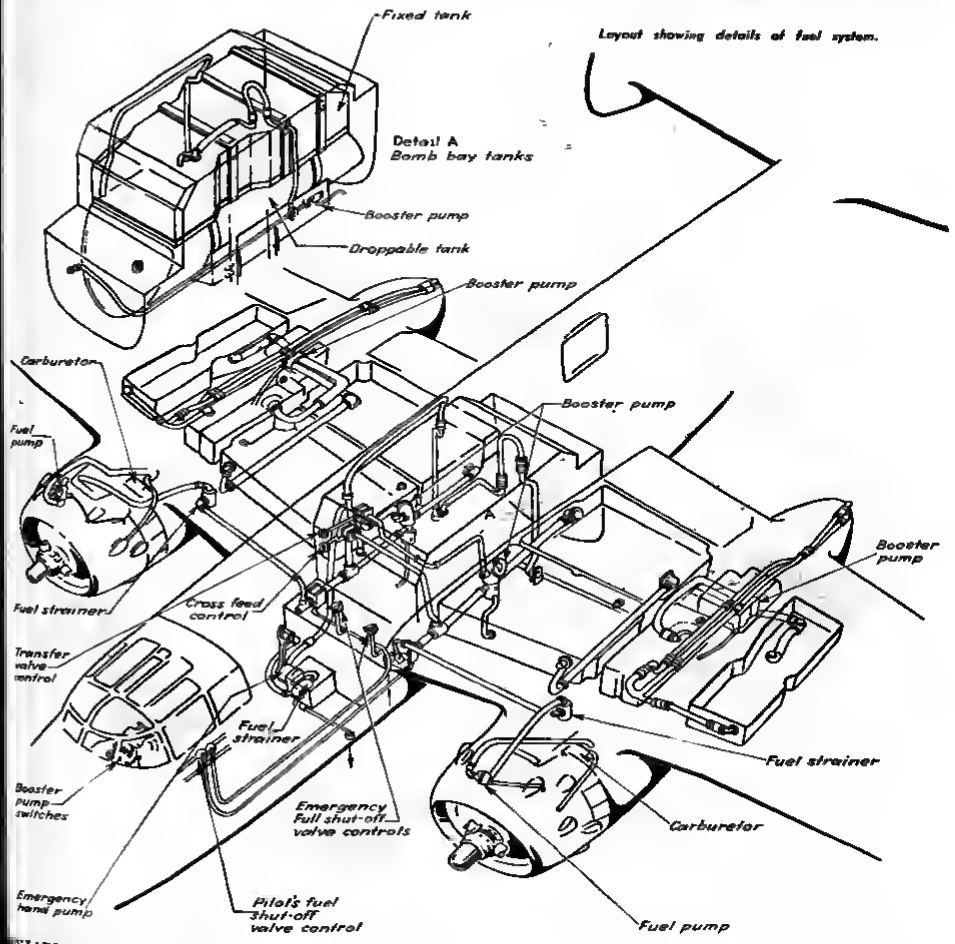
Control forces originated by the pilot are applied to the control column, located on the left side of the compartment, connected to a steel torque tube extending across the fuselage and having take-off horns at each end. Elevator cables extend aft along each side of the fuselage from control column horns to bellcranks in the aft fuselage. Adjustable push-pull rods connect each bellcrank to the respective elevator horns.

Elevators are joined by a torque tube connected to each elevator horn, and may be raised 25 deg. or lowered 10 deg. with respect to the horizontal stabilizer. A bungee is incorporated in the elevator control system to reduce forces on the control column.

Ailerons are controlled by clockwise and counter-clockwise movement of pilot's control wheel. Cables are led out of the control column torque tube, then aft to the aileron sector on the rear wing spar. Maximum upward aileron movement is 28 deg. downward is 14 deg.

Rudders are actuated by hanging type pedals. Control cables extend aft along each side of the fuselage from the lower outboard ends of the rudder pedal assembly to the horizontal stabilizer, then outboard on each side of the stabilizer to rudder sheaves

Layout showing details of fuel system.



at the outboard ends of the stabilizer. Rudders can be moved 20 deg. right or left with respect to vertical stabilizers. Loss of cables on one side of the airplane will not affect rudder control on the opposite side.

Elevator trim tabs are operated by control wheel on the left side of pilot's control pedestal. Aileron trim tabs are actuated by the forward control knob on the floor of pilot's compartment, and the aft control knob on pilot's floor operates the rudder tabs.

Power Plant and Propeller

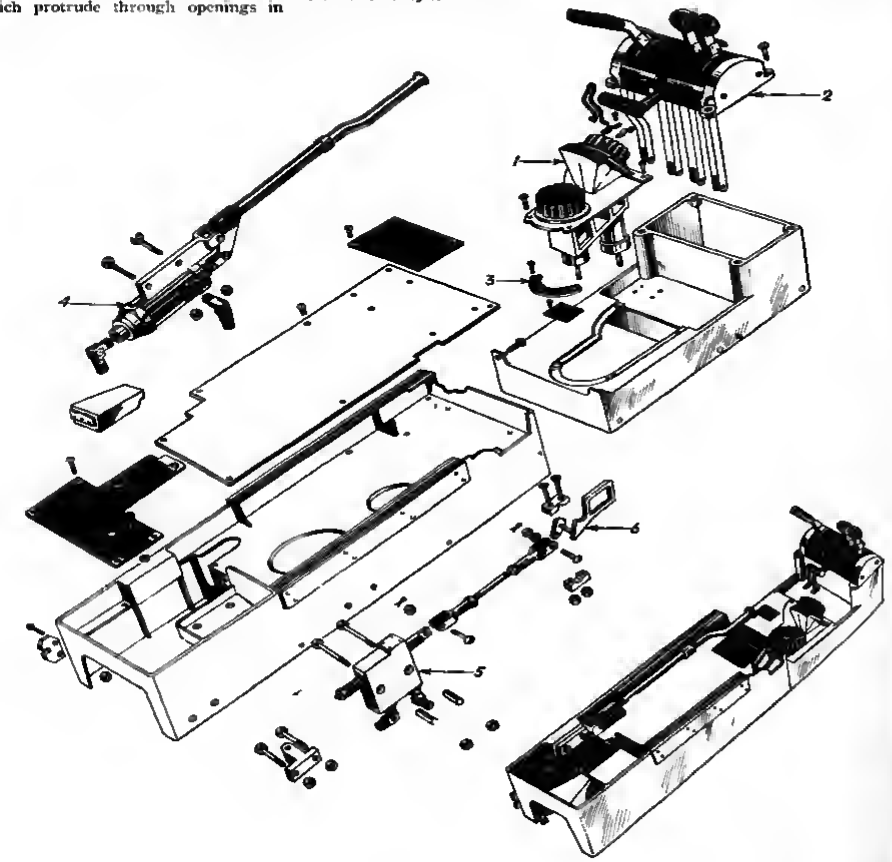
B-25H's and J's are powered by two Wright 14-cyl. twin-row R-2600 engines, each rated at 1,700 hp. for takeoff. The exhaust system uses Clayton-type flame-damping individual stacks which protrude through openings in the cowling. The Jack & Heintz JH-5F starter may be used as a conventional inertia starter to directly crank a warm engine without energizing it to direct-crank after energizing, if desired.

Performance Data

	B-25H	B-25J
Critical altitude	13,000 ft.	14,500 ft.
High speed (at crit. alt., normal power)	293 mph.	292 mph.
Service ceiling	23 800 ft.	25,500 ft.
Climb to 10,000 ft.	6.8 min.	6.1 min.
Service ceiling (one engine)	6,600 ft.	6,600 ft.
Takeoff run to clear 50 ft.	2,700 ft.	2,410 ft.
Landing distance over 50 ft. obstacle under	2,450 ft.	2,210 ft.
Max. rate of climb (military power at sea level)	1,950 ft./min.	2,090 ft./min.

Ignition is provided by two Scintilla SF14L-3 magnetos with 14-lobe breaker cams turning at half crankshaft-speed. Both magnetos are timed to No. 1 cylinder, and each is cooled by air from blast tubes running forward to the front of the engine.

Each engine is equipped with Model 1685-HA Holley carburetor to which flow of air is directed by a scoop mounted to the intake by a flexible joint. Main body of the air scoop is a casting containing a cold air door



Pilot's lower control pedestal: (1) Aileron and rudder tab controls, (2) hydraulic control cap assembly, (3) rudder tab indicator plate, (4) hydraulic hand pump, (5) pneumatic emergency brake valve, and (6) pneumatic emergency brake handle. Complete pedestal is seen at lower right.

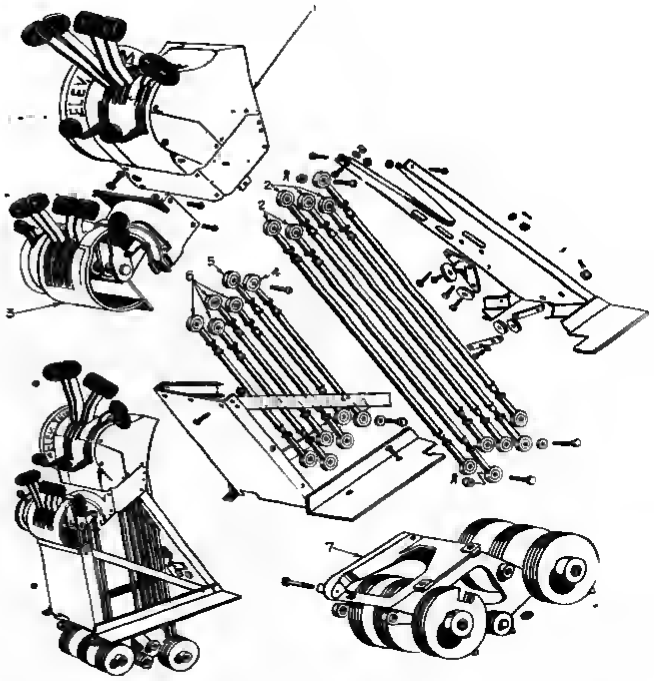
Pilot's upper control pedestal: (1 and 2) Main control quadrant and rod assembly, respectively, (3) auxiliary control quadrant (4) throttle and mixture rod, (5 and 6) right and left carburetor heat control rods, respectively, and (7) control pulley base. Pedestal assembly is seen at lower left.

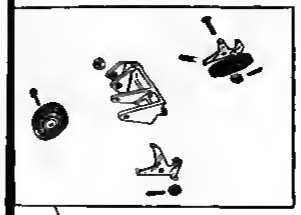
interconnected by linkage and controlled from pilot's control pedestal. A removable cover permits installation of either filter or baffle. When the cockpit control is in the *Normal* position, cold air is admitted to the carburetor, and when control is in *Icing*, warm, unmuffled air enters from the engine compartment.

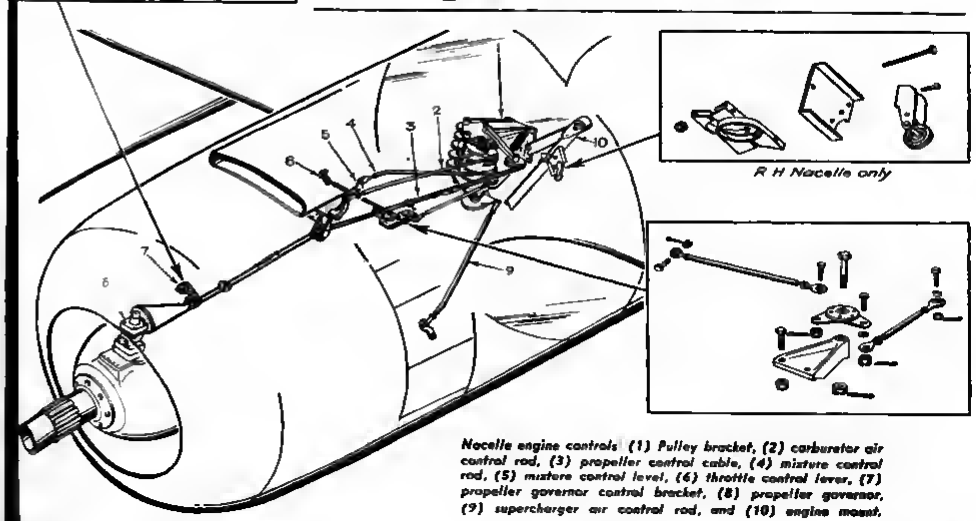
Power plants are equipped with three-bladed Hamilton Standard Hydromatic, full-feathering, constant-speed propellers, diameter 12 ft. 7 in. Blade settings range from low pitch of 22 deg. to high of 90 deg.

Electrical System

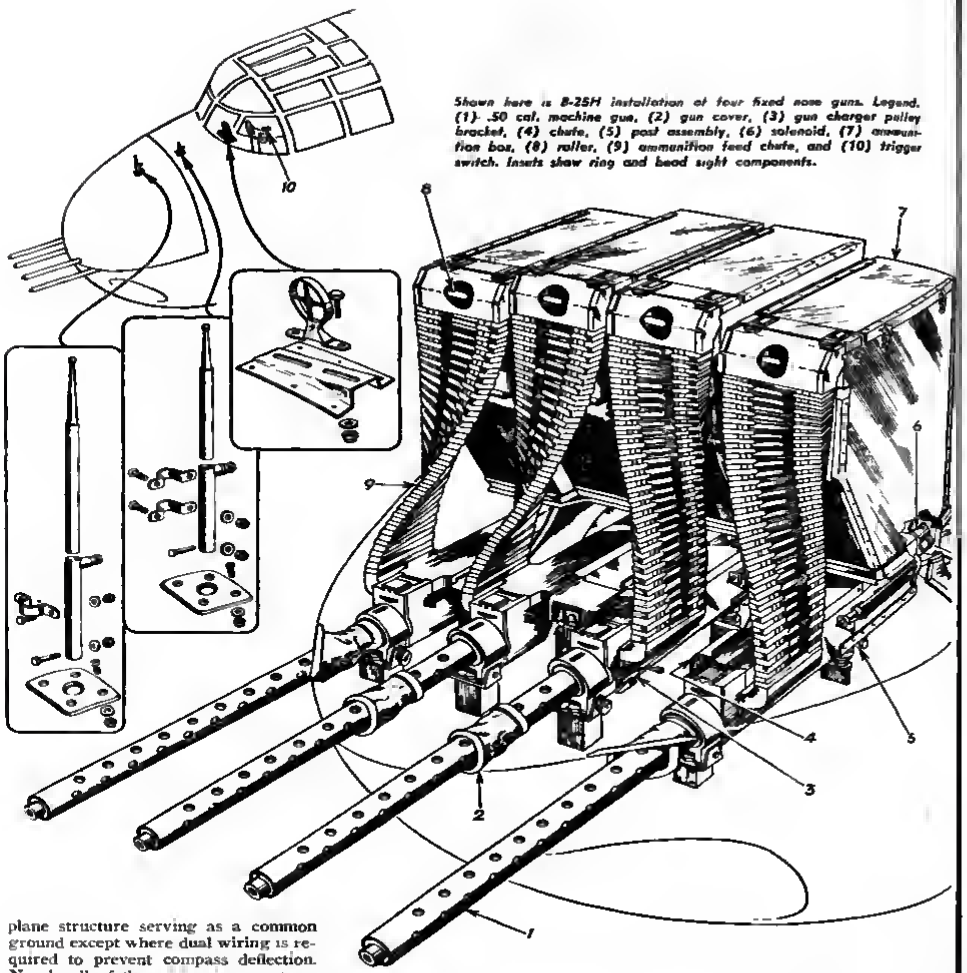
B-25H and J electrical systems are 24-v. d.c. single-wire type with the air-







Nacelle engine controls: (1) Pulley bracket, (2) carburetor air control rod, (3) propeller control cable, (4) mixture control rod, (5) mixture control lever, (6) throttle control lever, (7) propeller governor control bracket, (8) propeller governor, (9) supercharger air control rod, and (10) engine mount.



Shown here is B-25H installation of four fixed nose guns. Legend, (1) .50 cal. machine gun, (2) gun cover, (3) gun charger pulley bracket, (4) chute, (5) post assembly, (6) solenoid, (7) ammunition box, (8) roller, (9) ammunition feed chute, and (10) trigger switch. Insets show ring and bead sight components.

plane structure serving as a common ground except where dual wiring is required to prevent compass deflection. Nearly all of the wiring is open type, supported by clips and protected, where necessary, by insulating tubing, tape, or cord. Conduits inclose wiring in engine nacelles and wherever additional mechanical support or electrostatic shielding is necessary.

A 24v 34 amp-hr battery is located in each engine nacelle, aft of the firewall. Either battery will operate the electrical system, including starters.

Two engine-driven 200 amp. 30v. generators, one mounted on the supercharger housing of each engine, power the electrical system. Each generator is cooled by a blast tube leading to the generator from just aft of the propeller disk.

Radio Equipment

Radio system consists of the command set used for plane-to-plane communication; radio compass receiver; multiplace interphone system; and emergency transmitter for use in the life raft should the crew be forced down at sea. The B-25J has a liaison set for long distance plane-to-base operation, as additional equipment.

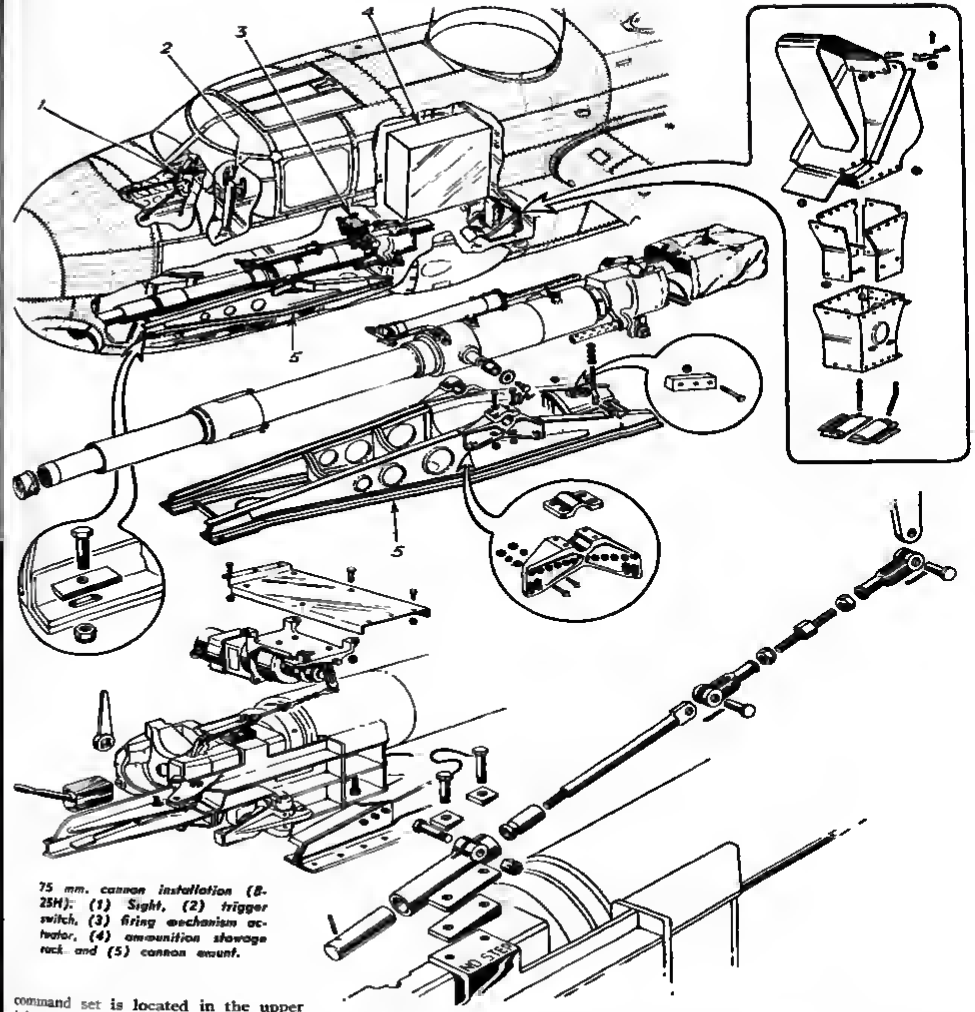
The command set includes a rack with two transmitters, rack with three receivers, combined dynamotor power supply and modulator, antenna relay and necessary command radio wiring. With exception of control boxes, the command set is located in the upper left forward portion of cannoneer's compartment on the B-25H, and in upper turret gunner's compartment on model J.

Radio compass consists of a receiver, remote control box, azimuth indicator, rotatable loop, and terminal junction box. The receiver unit is a 15-tube superheterodyne with a wide frequency range and is located on the forward portion of the cockpit floor, on the right side of the plane.

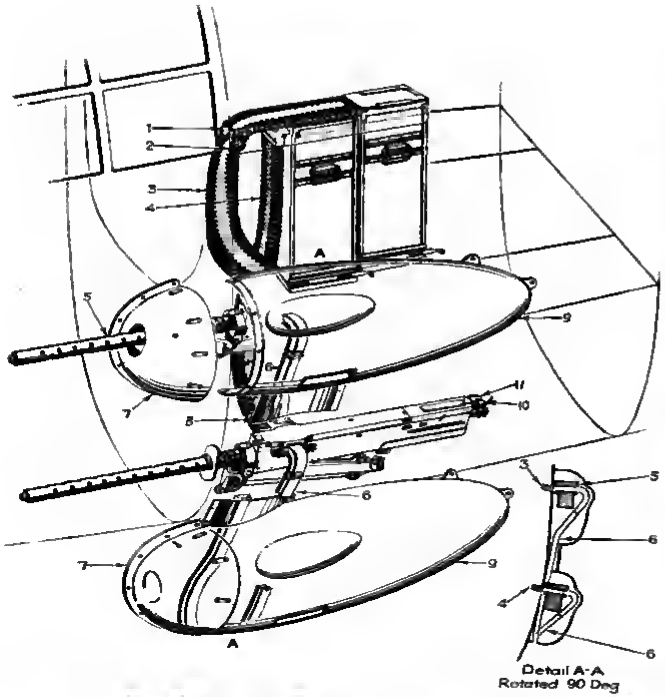
Emergency transmitter, consisting of a portable unit with self-contained generator, 300-ft. antenna, kite, balloon, signal lamp, hydrogen generator, and parachute attached to two canvas bags in which the equipment is stowed, is used by personnel forced down in the water, and is pre-turned to the international distress frequency of 500 kc.

Interphone equipment includes an amplifier, one jack box for each of the seven stations, and throat microphone and headset for each crew member.

Liaison set consists of a receiver and transmitter.



75 mm. cannon installation (B-25H): (1) Sight, (2) trigger switch, (3) firing mechanism actuator, (4) ammunition stowage rack and (5) cannon mount.



Fixed blister-gun installations (left and right side): (1, 2) Cartridge feed chute retaining strap, (2, 4) feed chute, (5) .50 cal. machine gun, (6) link ejector chute, (7, 8 and 9) gun fairing assembly, (10) solenoid, and (11) charger.

Gunnery Equipment

The B-25H has fourteen 50 cal machine guns and one 75 mm cannon, and the B-25J mounts twelve .50 cal. guns.

The cannon assembly in the B-25H, consisting of type T-13 weapon mounted on type T-13E2 recoil mount, is situated in the tunnel beneath the left side of the pilot's compartment. Cannon muzzle projects forward through a blast tube in the lower nose section and the breech extends aft to the left forward side of cannoneer's compartment. Cannoneer loads the gun and pilot fires it.

The all-metal nose forms a compartment for the four nose guns and ammunition boxes. Upper portion of the nose is hinged to provide access to the guns and ammunition belts. Guns are mounted side by side, are charged by cannoneer and fired by pilot.

Two guns are installed on each side of the fuselage just outside cannoneer's compartment. Attached to metal brackets, they are enclosed by metal blisters fastened to fuselage. Ammunition boxes are supported on a shelf structure at each side of cannoneer's compartment. Blister guns are also fired by pilot.

The upper turret is installed on a support pedestal in the aft portion of cannoneer's compartment. The field of fire of the two .50 cal. guns in azimuth and elevation is automatically controlled by cams and switches in series, allowing gunner to freely follow a target without the bullets striking any part of the plane.

Waist guns are flexible, mounted on a trunnion yoke, and project through a canvas boot in a transparent glass blister, one on each side of fuselage aft of the bomb bay. Each gun is provided with bungee cables to aid gunner in maneuvering during firing periods. Ammunition is stored on a shelf aft of the guns and is led to them through fixed-feed and flexible chutes.

Tail installation consists of the Bell Type M-7 turret with a twin-gun adapter mounting two Type M2 .50 cal machine guns. Feed chutes are equipped with booster motors.

In the B-25J, the four nose guns and cannon are replaced by a fixed forward-firing .50 cal. gun and one flexible .50 cal. gun. The flexible gun operated by the bombardier, is placed in a ball-and-socket mount installed in the foremost point of the nose directly above the bomb-sighting window.

Weights

	B-25H (lb.)	B-25J (lb.)
WING GROUP		
Center section	1,824	1,788
Outer panels	924	880
Tips	16	16
Ailerons	98	100
Flaps	172	174
Total	3 020	2 958
TAIL GROUP		
Stabilizer	188	196
Elevators	126	136
Fins	110	101
Rudders	86	85
Total	510	508
BODY GROUP		
Fuselage	2 082	1 959
LANDING GEAR		
Main	1,578	1,562
Nose	260	274
Bumper	12	12
Total	1 850	1 948
NACELLE GROUP		
Nacelles	960	914
POWER PLANT GROUP		
Engines as installed (2)	4,000	3,930
Engine accessories	358	217
Power plant controls	188	133
Propellers and spinners (2)	904	973
Starting system	102	99
LUBRICATING SYSTEM		
Tanks and protection	201	204
Piping, etc	96	343
FUEL SYSTEM		
Tanks and protection	1,200	1,079
Piping, etc	280	284
Total weight: Power plant group, lubricating system and fuel system	7,329	7,080
FIXED EQUIPMENT		
Instruments	126	101
Surface controls	390	433
Hydraulic system	210	186
Electrical system	612	533
Communicating system (Army)	235	284
Armament provisions	2,035	2,080
Furnishings	694	574
Anti-icing equipment (defrosting tubes)	81	75
Total	4,173	4,287
UNIT WEIGHTS		
Wing group (net area 609.5 sq. ft.) lb. per sq. ft.	4 95	4.81
Tail group (net area 223.4 sq. ft.) lb. per sq. ft.	2.28	2 27
Lubricating system per gal. of Oil (75 gal.)	3 96	5 91
Fuel system per gal. of fuel (974 gal.)	1 82	1 34
GROSS WEIGHTS		
Normal gross weight	28,330	27,000
Alternate gross weights	33,047 to 36,000	31,757 to 35,821
Total weight empty	19 924	19,488

Useful Load

	B-25H Lb.	B-25J Lb.
Crew (including parachutes)	1,000	1,200
Oil (400 gal. at 7.5 lb.)	300	300
Oil trapped in system	60	195
Fuel (634 gal. at 6 lb.)	2,604	2,604
Fuel trapped in system	16	16
Photographic equipment	31	31
Pyrotechnic equipment	14	14
Armament	1,462	1284
Ammunition	795	480
Bombs	2,135	2,100
Useful load (normal)	8,406	7,539

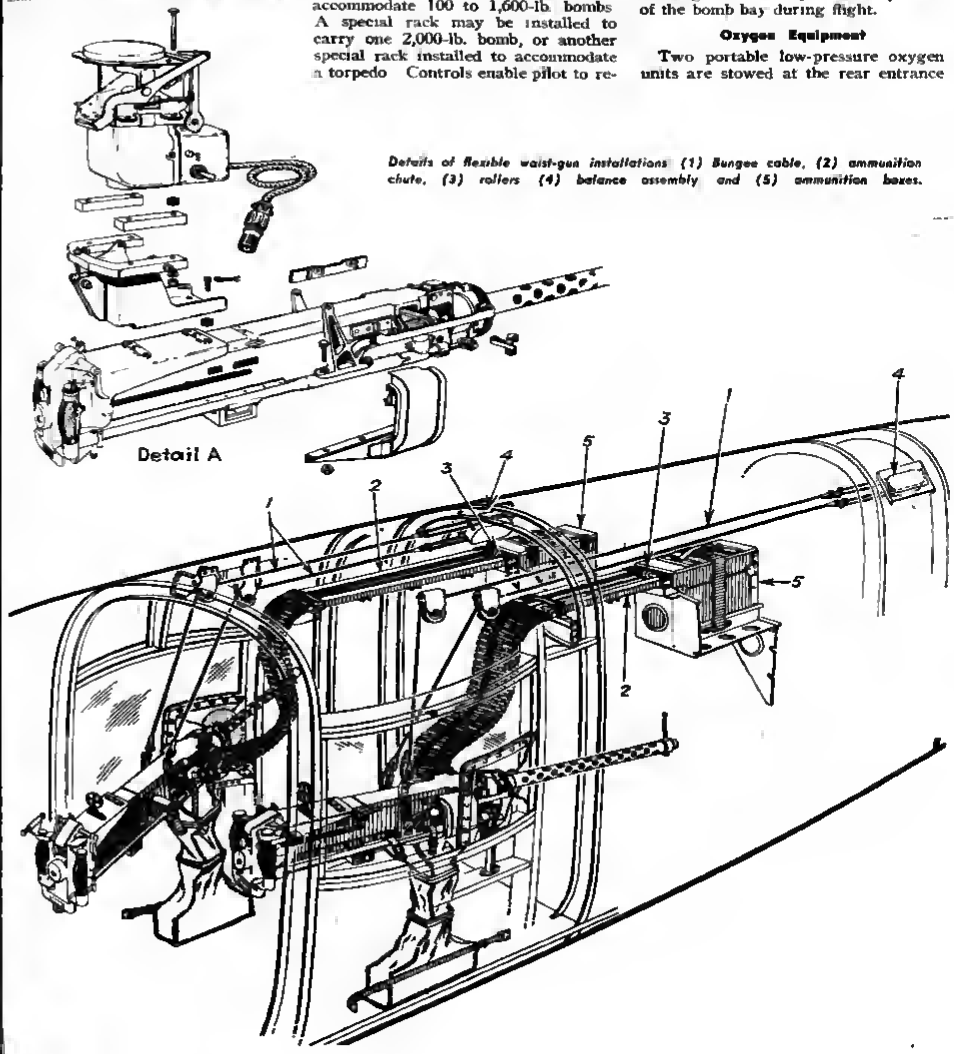
The fixed nose gun is mounted on the right side of bombardier's compartment, its barrel projecting through the nose, and is fired by the pilot. Armament of the B-25J is otherwise identical with that of the B-25H model.

Bombing Equipment

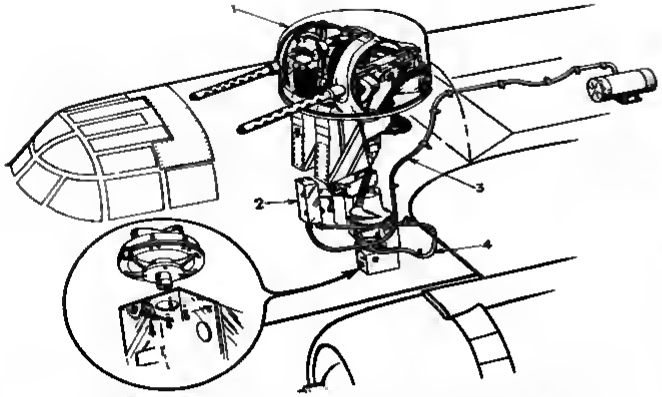
The bomb bay is equipped with fixed ladder type racks designed to accommodate 100 to 1,600-lb. bombs. A special rack may be installed to carry one 2,000-lb. bomb, or another special rack installed to accommodate a torpedo. Controls enable pilot to release bombs from the racks either electrically or mechanically. A manhole in the crawlway over the bomb bay is provided for ease in stringing bomb hoisting cables and permits inspection of the bomb bay during flight.

Oxygen Equipment

Two portable low-pressure oxygen units are stowed at the rear entrance



Details of flexible waist-gun installations (1) Bungee cable, (2) ammunition chute, (3) rollers (4) balance assembly and (5) ammunition boxes.



Upper gun turret installation: (1) Master upper turret, and (2, 3 and 4) azimuth resistor box, cable to amtor amplidyne, and cable to brush box, respectively.

of the bomb bay crawlway. When in use, one is mounted behind pilot's seat and the other is attached to the forward corner of cannoneer's compartment ceiling

Type AN-R-5 demand regulator is mounted on the side of each oxygen cylinder and automatically controls flow and dilution of oxygen. As the user inhales, a diaphragm is inflated, opening a valve permitting oxygen to flow through the regulator. Oxygen then mixes with free air in an amount governed by an aneroid valve which controls an air port and an oxygen port. At sea level the air port is open and the oxygen port is closed. As the altitude increases, the aneroid expands, closing the air port until finally, at about 30,000 ft., the air port is completely closed and the regulator is delivering pure oxygen.

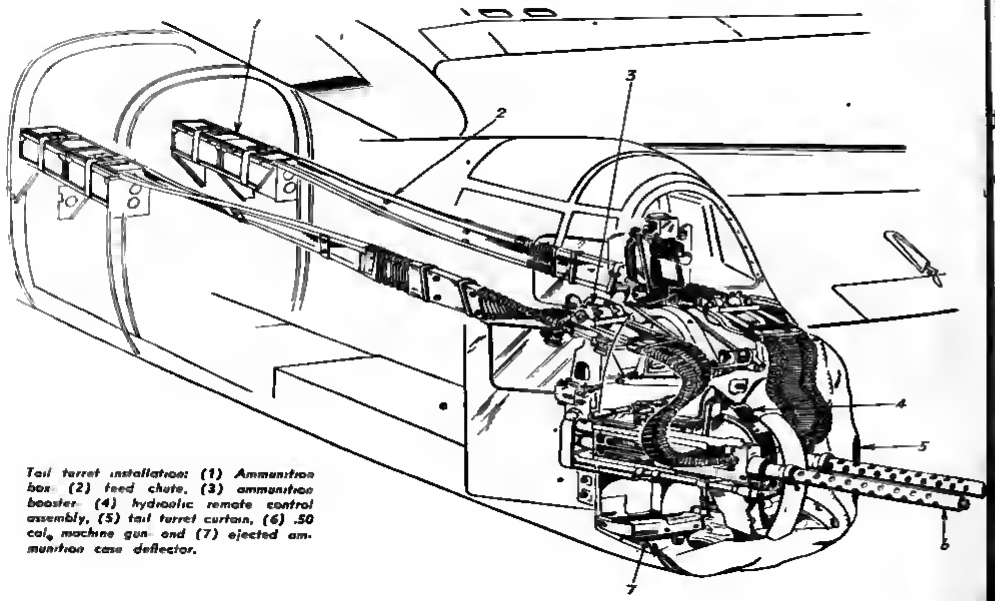
Instrument and Photographic Equipment

Instruments on the B-25 are divided into four general classifications: Vacuum system, airspeed system, engine system, and miscellaneous. Normal complement of instruments applicable to a twin-engine bombardment plane is utilized and offers no unusual installations.

A type K-24 camera is located just aft of the bomb bay in the fuselage rear section. Photographs are taken through a window in the fuselage floor through a range of 50 deg. fore and aft of vertical.

Cold Weather Provisions

Three interchangeable Stewart Warner fuel-air heaters are used, each with an output of 50,000 Btu./hr. Ventilating and combustion air is sup-

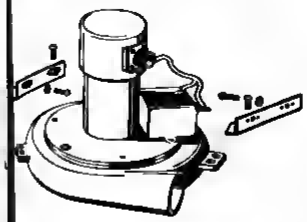


Tail turret installation: (1) Ammunition box, (2) feed chute, (3) ammunition booster, (4) hydraulic remote control assembly, (5) tail turret curtain, (6) .50 cal. machine gun, and (7) ejected ammunition case deflector.

Detail A

Front fuselage heating and ventilating system (B-25J): (1) Heating and ventilating control, (2) bombardier's deicer panel, (3) heating and ventilating tube, (4) bombsight heating, ventilating, and defroster tube, (5) blower to flexible tube adapter, (6) bombardier's heating and ventilating outlet, (7) pilot's compartment duct, (8) duct, wing to fuselage, and (9) turret compartment auxiliary defroster.

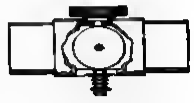
Rear fuselage heating and ventilating system. (1) Defroster for tail gun window, (2) Avia defrosting heater for tail turret, (3) waist gun window defroster manifold, (4) defroster tube, (5) system control, and (6) heating and ventilating system, radio compartment.



Detail D

Detail A

Detail B
on bottom side of heater



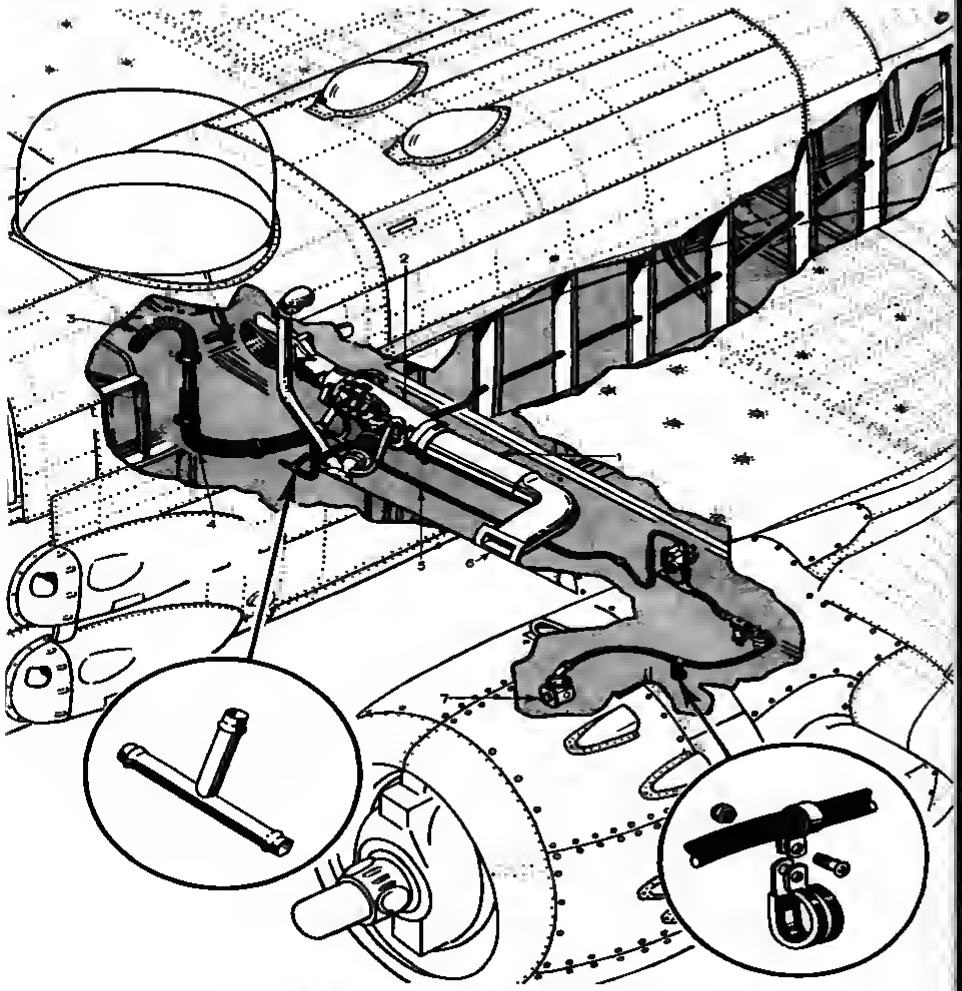
Detail C

plied by ram from openings in the cannon tunnel, wing leading edge, and external air scoops in the fuselage.

The forward heater is located aft of the nose guns and supplies hot air for defrosting transparent areas of pilot's enclosure, and heat for pilots and navigator.

Second heater extends into the left center section wing and supplies heat for cannoneer's compartment and upper turret.

The rear heater is mounted aft of [illegible] left waist gun window and turns[illegible] hot air for defrosting waist and tail [illegible] windows. Provisions have been [illegible] for use of electric gun-heaters [illegible] needed.



Center-section heating and ventilating system. (1) Heater inlet duct, (2) heater assembly, (3) pilot's auxiliary defroster, (4) heating and ventilating air duct, (5) fuel hose line, (6) leading edge air intake scoop, and (7) heater fuel pump.

How May We Simplify The Postwar Laboratory?

PART III OF A SERIES

By K. R. JACKMAN

Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego

'There is danger in an organization [illegible]—danger that it may be mistaken [illegible] an organization'—Arthur D. Little

Mass production methods are constantly being devised or improved by the engineer and the researcher—to simplify the other man's work. But unfortunately the laboratory technicians can't apply such mass methods to their own labors. To expedite these creative activities takes something else. And the managers must ever be watchful that "paper work" is not confused with progress.

THERE IS NO SUBJECT concerning which scientific discussion is more active at the present time than the relation of research to industry, especially the place of the laboratory under management.

In Parts I and II of this series, the discussion has been concerned chiefly with the exposition of the advantages to industry of participation in scientific research, particularly in the aviation industry, and of the importance, national and economic, of an increase in the volume of research work of all kinds.

But together with propaganda in favor of research there is necessary a study of the best methods of organizing research work for industrial aviation purposes and of the conditions under which such work should be conducted. This chapter is intended as a contribution to the organizational problem in an effort to stimulate active discussion on a subject on which little has been written as applicable to the aircraft research and development laboratories.

It should be emphasized at the outset that the organizational ideas herein presented are those of the writer or of those quoted and do not, therefore, necessarily reflect the organization or business policies of the Consolidated Vultee Aircraft Corp.

In the aviation industry, as in most of the large industrial enterprises, there has been a remarkable awakening to the value of research and test, and a still more phenomenal growth of research and development laboratories, due to the national emergency. Many aeronautical corporations which were not provided with research facilities heretofore are making such provisions, while small corporations and subcontractors which cannot afford to support extensive laboratories themselves are combining to maintain laboratories doing work for the whole industry.

The application of an elaborate organization to the aircraft industry in the past five years has undoubtedly aided plane production. There has been a tendency, however, to spend considerable time in preparing an impressive looking organization chart, and then, with considerably less thought, to place men's names in the chart boxes and assume that the job has been completed without further supervision and follow-up.

Mass production methods—that work on a production line—cannot be applied in the same manner to the engineering and research departments. The "red-tape" and "paper-shuffling" in many engineering departments, and to a certain degree in research and test offices (due primarily to this rapid wartime expansion and the desire of management to keep control) may have caused emphasis to be placed on paper work rather than on drawings and tests produced, and on "proper" routine and "procedures" within the department rather than on individual engineering initiative.

It may well be that, in the postwar years, the aircraft industry can profitably consider simpler personnel organizations and less hampering red-tape than has been necessary to keep up "mass" production. The prewar method of using sketches and 'arm-waving" to transmit ideas between the research laboratories and the shops may again be more economical in the months to come than the complete production drawings and "planning and schedul-

Convair's "hydrotest" of a Liberator wing. Improvements in research laboratory technique now permit one operator to load test wing by hydraulic jacks in only a few minutes.

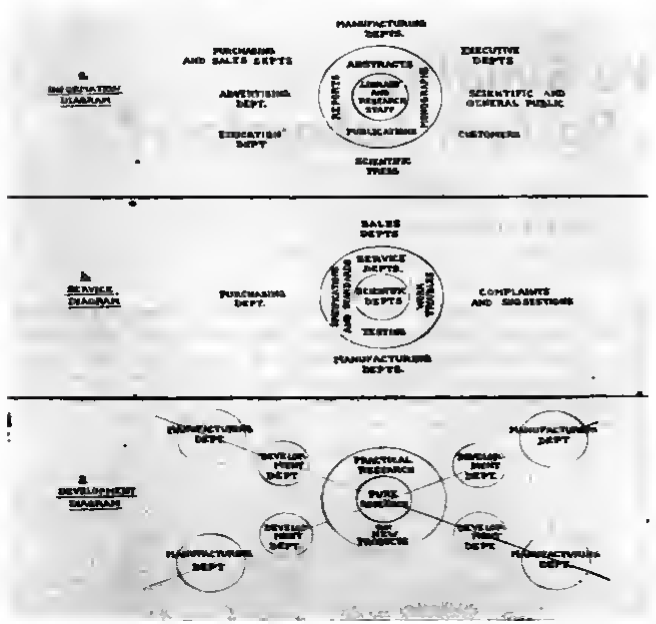


Fig. 1. Flow of (a) information, (b) service, and (c) development from modern research laboratories to industry is represented in these annular diagrams. (From "The Organization of Industrial Scientific Research," by C. E. K. Mees, McGraw-Hill Book Co.)

ing" records demanded today to cover single test specimens and research set-ups.

What Is Organization?

"The uninitiated look at the lines in an organization," says Bichowsky, [1-a] "taken from a chart which shows the descent of executive authority and say that that is organization. The wise look at the lines, usually undrawn on a chart, which represent the working relations of the various units among themselves. Hence it is of very great importance, very early in an organization of a research laboratory, to set up the mechanism of cooperation between departments, while at the same time avoiding overlapping of authority and responsibility which too often marked relation between research and other parts of the company."

The next most important department, whose relationship to research must be defined clearly, is engineering, or, as it is often called, development. This is the case even where research is a subdivision of engineering. Bichowsky warns that perhaps this is the case where it is most important to define the line of demarcation of activities and responsibility and to work out methods of liaison.

As has been pointed out in the two previous parts of this series, the essential difference between engineering (that is to say product design) and research is the point of view from which the problem is attacked rather than the nature of the problem.

Laboratory Functions

Since the laboratory is a staff department of an industry, its organization must be such as to enable it to carry out staff functions related to all other departments of the industrial organization. Primary among these staff functions, as summarized by K. Mees, [III-3] Director of the Eastman Kodak Research Laboratory, are:

1. The provision of *information* regarding the technical and scientific matters in which the industry is interested, and the supply of this information in a form suitable for the education of the employees, of the customers, and of the general public.

2. *Service* in the form of provision of specifications and standards for materials, the making of analyses and tests, assistance in regard to difficulties, and finally to customers in relation to problems arising from the use of the product.

3. The development of new processes or products, utilization of by-products, and the development of new departments of the industry.

Mees has expressed these functions of the typical industrial laboratory by means of annular diagrams, as shown in Fig. 1.

The service work (Fig. 1b) which the laboratory provides for other departments of the industry is best accomplished by men trained in laboratory methods, possessing a scientific viewpoint, but working especially for the department needing the service. The ideal thing would be to have a high-caliber chemist, physicist, metallurgist, or test engineer attached directly to the serviced department, such a man working closely with a specific type of problem can give the best technical service.

This is, of course, impracticable since it would cost too much; but Mees states that from his wide experience "an entirely satisfactory solution can be obtained by having a man in the laboratory who deals with the problems of a particular department and who spends a great deal of his time in that department—doing his experiments, however, in the main research laboratory under the supervision of one of the senior executives of the research laboratory.

"As soon as this junior research man meets a difficulty which requires greater knowledge than he possesses or knowledge in a different branch of science, the problem can be taken up by his chief and transferred to some other section of the laboratory, where it can be studied and a solution found, the solution then being given to him to be taken back to the manufacturing department and put into operation."

The organization of the *development* work shown in the annular diagram in Fig. 1c is founded upon pure research done in the department, which undertakes the necessary practical research on new products or processes as long as they are on the laboratory scale and then transfers the work to special development departments or groups which form an intermediate stage between the laboratory and the manufacturing department.

The basic laboratory organization, irrespective of its industrial affiliations, will, therefore, consist of (1) a section of *administration*, which will be responsible for the direction of the work, the control of accounts, the personnel problems, and the issuing of reports, (2) a section of *information* which will operate the technical and specialized research phases of the library, prepare abstracts of the literature, keep in touch with the patent department and constitute its technical staff, and prepare reports and publications of all kinds; and (3) the *scientific* section, which will carry on the operation of the laboratory work.

In these three sections, possibly the function of the library function will be the only one questioned by some of the readers (those who now have their library under the engineering department or as a separate department). The exact organization location is not so important, provided the research staff and test engineers have easy access to the technical literature and the laboratory reports are properly abstracted and cross-referenced to make future use possible. (A future article in this series will deal more in detail on technical reports and the library function.)

Basic Organization Types

There are only four elemental types of organization [III-3] which can be applied to modern industry—*line* or military organization, *functional* or staff organization *line and staff* organization, and the *committee* organization.

The line organization is the oldest and is based on military organizations or field armies. Inasmuch as this type demands absolute discipline and the lines of authority and instruction are rigidly enforced, each man is directly responsible to his superior and theoretically cannot contact or receive aid or instruction from any other superior except through his superior.

The functional or staff organization is the exact opposite of the line organization in that lines of authority and instruction pass from each supervisor to each foreman. This type of organization gives the absolute maximum use of the knowledge gained from experience of all of the supervisors. There is danger in this type through lack of discipline and having too many bosses. Staff functions are concerned with *planning*, line functions with *operation*. The founders of industrial enterprises have usually taken staff functions upon themselves, creating a line organization to carry them out.

The line and staff organization combines some of the advantages of both the line and functional types of organization and is common in industry. In a chart of this organization, the chiefs of the various departments or divisions are shown horizontally. These chiefs may have different responsibilities but their authority remains equal. Each man has definite staff functions for which he alone is responsible.

In the committee organization is found a simple modification of the conventional line and staff type. The division heads, such as the chief engineer, works manager, treasurer, assistant general manager, etc., serve as a committee which acts on various policies and authorizes control procedures which affect the management of the entire company. This organization gets away from the absolute rule by one man and substitutes the more democratic opinion ruls of top key men of the organization.

The committee organization, properly used, can be a great boon to a research laboratory, inasmuch as the joint opinions of the section or department heads, each expert in a particular field, can more quickly solve technical problems and formulate policies for the good of the laboratory than can even the most learned director of research.

A practical illustration of the common line-and-staff organization is that in the Chevrolet Motor Div of the General Motors Corp, shown in Fig. 2. J. M. Crawford and P. A. Collins [III-4] give us a clear picture of the internal organization and functions of this great corporation (from which the aviation industry may learn many industrial "shortcuts") as it existed in 1938 before its unnatural wartime boom. The chief engineer establishes all policies and contacts with the management and departments within Chevrolet, and with Fisher Body, the styling section, and other corporation divisions. The assistant chief engineer is responsible for the coordination of all activities of the design, production, and experimental engineers, as well as those of the drafting room.

The experimental engineering division (Fig. 3) comprises the necessary group to build experimental material to test and report the performance of experimental and production articles, as well as competitive products, to supervise the design-checking of production material; to contact with the design-engineering division as to corrections and suggestions; and to prepare and tabulate necessary weight data and analyses. This department must prevent defective design from getting into production and it must also conduct fact-finding experimentation.

The General Motors Corp. and its affiliates, such as Chevrolet, Buick, Pontiac, etc., probably comprise the outstanding example of a central research laboratory serving outlying pro-

ENGINEERING ORGANIZATION AT CHEVROLET, 1938

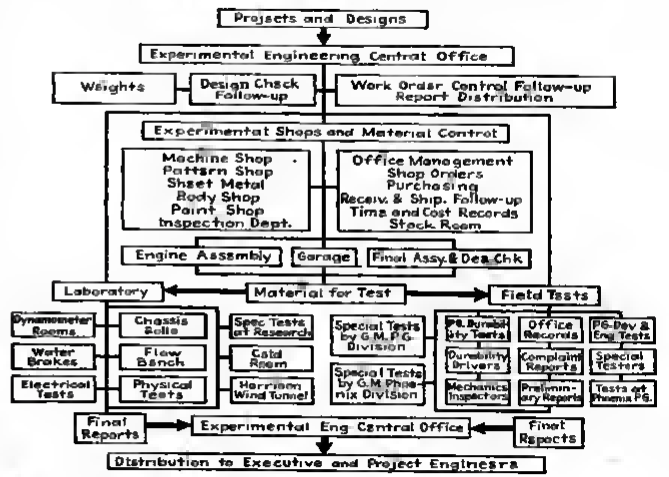


Fig. 2. Industrial application of line and staff functions is illustrated by this chart depicting an auto company's engineering organization. (From "Experimental Procedure of Testing at Chevrolet," by J. M. Crawford and P. A. Collins, "Automotive Industries.")

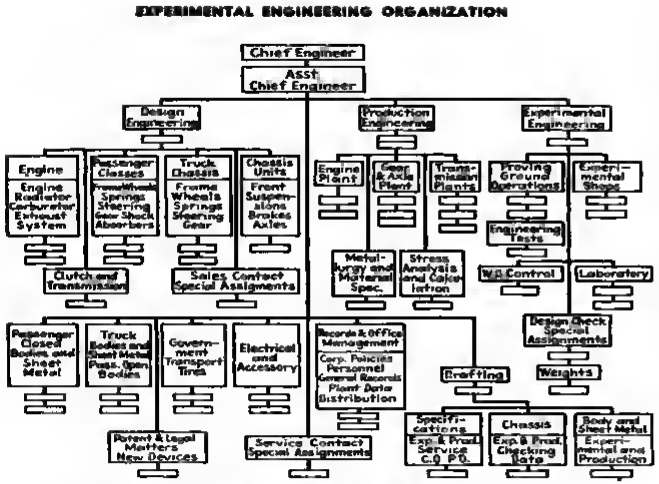


Fig. 3. Chart showing work flow within a typical automotive division evidences importance of practical laboratory and field tests. (From "Experimental Procedure of Testing at Chevrolet," by J. M. Crawford and P. A. Collins, "Automotive Industries.")

duction laboratories, each of which contributes to the central laboratory upkeep in payment for research services received.

Still another method of classification of the seven principal types of organized research laboratories in existence today has been given us by Mees [III-1]. These, with illustrations of each added, are as follows:

1. University Laboratories—nearly every American university.

2. Government research laboratories —Bureau of Standards, Bureau of Mines, Bureau of Chemistry of the Department of Agriculture, Forest Products Laboratory.

3 Foundation research laboratories —Rockefeller Institute for Medical Research, Bartol Research Foundation of the Franklin Institute, Armour Research Foundation.

4. Industrial research laboratories maintained by individual firms—E. I. du Pont, American Telephone & Telegraph Co., Eastman Kodak Co., General Electric Co., General Motors Corp., Consolidated Vultee Aircraft Corp., Lockheed Aircraft Corp.

5. Cooperative research laboratories —National Canners' Assn., Portland Cement Assn., Tanners' Council of America, American Institute of Baking.

6 Industrial fellowship laboratories —Mellon Institute of Industrial Research, Battelle Memorial Institute.

7. Private consulting research laboratories—Arthur D. Little, Inc., The Miner Laboratories, Thomas & Hochwalt Laboratories.

"Departmental" Vs. "Cell" Systems

Whether a laboratory is of the "divergent" type (dominated by one director or researcher, as described in Part 1) or of the "convergent" (staff rule) type there are two forms of organization possible for the whole of its scientific work. These are sometimes referred to as the *departmental* system and the *cell* system.

"In the departmental system" states Mees, [III-1] "the work of the laboratory is classified into several departments—physics, chemistry, engineering, and so on—according to the number necessary to cover the field; and each of these departments has a man of suitable scientific attainments in charge." In a large department each of these men will, in turn, have assistants responsible for sections of the department, all the heads of the departments finally being responsible to the director of the laboratory. Disadvantage of this system is the danger of stifling initiative of younger and less experienced men at the bottom of the ladder.

Under the alternative, or cell, system the laboratory consists of a number of investigators of approximately equal standing in the laboratory, each of them responsible only to the director, and each engaged upon some specific research. Of course, the individual investigator may be provided with assistants as may be necessary. Disadvantage of the cell system of laboratory organization lies in the tendency of investigators to become secretive, to refuse cooperation, and to feel resentful if their research work is surveyed. It may be very difficult for a new investigator to cover the research projects of a "cell" co-worker who has left or become ill; some valuable projects have thus been left unfinished.

In practice, a balance between the departmental and cell systems of organization is essential in a research laboratory. The form of organization which is easiest in administration is undoubtedly some modification of the departmental system, since only by this means can young students fresh from college acquire adequate training and at the same time keep in touch with different branches of their subject.

Research Recently Organized

Until the 20th Century, industrial research remained largely a matter of the unorganized effort of individuals. Early in the 1900's a few companies organized separate research departments and began a systematic search not only for the solutions to immediate problems of development and production, but also for new knowledge that would point the way for the future.

It was in 1900, points out Boyd [I-2], that Willis R. Whitney began research in a corner of one of the buildings of the General Electric Co. in Schenectady. The United States Bureau of Standards was not constituted on its present basis, under which organized research is a part of its activities, until 1901. And it was a few years after that before the United States Bureau of Mines began doing organized research. It was about 1902 that Charles L. Reese organized the Eastern Laboratory, pioneer among du Pont's several research laboratories. Frank B. Jewett, head of the Bell Telephone Laboratories, started in his career of research in the telephone business in 1904. And Eastman Kodak's research laboratory was established under C. E. K. Mees in 1913.

Organized research as a separate activity was first begun by Westinghouse Electric in 1917. The central Research Laboratory of General Motors, now headed by Charles F. Kettering, was established in 1910, although each one of the various divisions of the corporation has conducted research independently from the time it began making cars.

Need for creating efficient and flexible organizations was stressed by L. W. Walker [III-3] in 1943 in a study defining the most suitable types of organizations to fit the sizes and personnel of various companies. Several of his charts, applicable to wartime aircraft engineering divisions, might be simplified to suit postwar units.

Mr. Walker visualizes a typical engineering department handling more than one design project and designed to operate satisfactorily with 100 to 1,000 personnel. Here, the chief engineer would have reporting to him three major department heads—the chief of aerodynamics, who could be called the director of research; the administrative engineer, who is the business management end of engineering; and the assistant chief engineer, who is responsible for the output of engineering information to the factory.

Also visualized is an ideal engineering department for a larger company in which the chief engineer is also vice-president and has fewer design duties and more sales and policy responsibilities. The chief of the technical staff, in this case, is responsible for all research in the preliminary design of experimental airplanes, and he is also responsible for the administration of the structures department.

Research and Engineering

In the line and staff organization mentioned earlier and in the two setups described in the paragraphs above, the testing and research facilities have been depicted as allocated to the engineering department. There is considerable argument for and against the placement of the research laboratory under engineering direction.

"The decision whether a proposed laboratory is largely to undertake extensive research or is to confine itself for the most part to intensive investigations," comments L. A. Hawkins,[I-8] executive engineer of the General Electric Research Laboratory, "is an important factor in the problem of the relation of the research staff to the other departments of the company. In general, two schemes are in successful operation. In one plan, research and engineering are in effect consolidated under a single head, with the title of chief engineer or director of research, and with responsibility both for research and for engineering development and design, and often for control, in part at least, of factory process. In the second scheme, the research laboratory is independent of engineering and factory departments, and its director's duties in regard to them are of an advisory character.

"Each scheme has its advantages. Direct control by the research head of engineering and of factory process insures the most immediate and effective utilization of the research findings in engineering development and in production. The second scheme, of making the research laboratory an independent department, without direct responsibility for engineering and manufacture, has the advantages of enabling its director to take a more detached view and sometimes to gain a better perspective of the company's major problems, and to some extent of freeing the research staff from the constant pressure of commercial considerations and the research facilities from the encroachment of production requirements, which in any well ordered business must take precedence over experimental needs."

Bichowsky [I-4] believes that 'research should in most cases be considered as an executive function, because its policies are, in the long run, going to control the future position of the organization."

He continues: "This conclusion is not universally accepted. In most organizations the research division is still considered a part of engineering, but the tendency is to promote research to an executive function, as is witnessed by the fact that the most powerful research organizations, such as General Motors, General Electric, U. S. Steel, etc., have frankly adopted the policy of independent research organization and give to the director of research the title of vice-president.

"The advantages of having on the board of directors and on the administrative board of the company one who knows research—i.e., the future trends of the business—is so evident that the wonder is that more companies do not adopt this policy.

"However, research usually begins with a comparatively small group, headed often by a relatively young man. It is not usually considered part of wise policy to give to such a beginner the very important position of vice president. Indeed, in many cases, the promotion of research to independent status has come as a sort of reward to a relatively old research director as a result of long and meritorious service."

So much for opinions of several leading research directors. Now for facts on the placement of research in industry: Raymond Stevens,[III-5] vice president of Arthur D. Little, Inc., and director of survey of Research in Industry in which over 2,200 industrial laboratories employing more than 70,000 people were questioned, says:

"It is generally accepted that research, as a staff function, receives the direct attention and policy supervision of the principal executive management of the industrial corporation. There is no standard pattern for the place of the research department in the organization, however, and occasional attempts are still made to subordinate research to production, sales (engineering), or other functions. Where research has been successfully established on a continuing basis, such subordination to other functions is not general practice.

"Committee management is found to be more frequent for research than in other organizational units in industry. Such committees represent other major divisions and define broad research objectives, establish policies and exercise financial control. The research director supervises the research within the limits thus imposed. In the absence of such practice, equivalent provision for cooperation with other departments usually is provided.

"In a majority of companies questioned on the subject, the final decision in authorizing individual research and development projects rests with an officer of the company, most frequently the president; only 19 percent rely upon a committee, with the president usually a member."

The subject of organization as applied to research is so broad and its importance to aviation laboratories in their formative years so vital, that only the high points can be covered in this and the following articles. In next month's article (Part IV) we will further consider the place of the research laboratory in an aviation company considering whether it should be centralized or subdivided, a division of the engineering department or on separate status, responsible to some department head or to top management.

The writer will appreciate the viewpoints of the readers on these highly controversial subjects in order that the information being gathered may be more representative of the total aviation research industry.

References to Part III

For those researchers who wish to study further the subject of research organization, the following references may be of help.

Note: Articles once referenced in any part of this series will be referred to by *part number* and by *reference number*, i.e., (I-4) indicates Part I, Reference 4.

(III-1) *The Organization of Industrial Scientific Research*, by C. E. Kenneth Mees, McGraw-Hill Book Co., N. Y. C., 1920.

(III-2) *The Organization, Direction and Support of Research in the Physical Sciences* by Hugh S. Taylor, Princeton Univ., *Science* Mar. 31, 1944 (Vol. 99—No. 2570).

(III-3) *Growth of Wartime Aircraft Organization* by L. W. Walker, *Aero Digest*, June 1943.

(III-4) *Experimental Procedure of Testing at Chevrolet* by J. M. Crawford and P. A. Collins, General Motors Corp., *Automotive Industries* Part I Aug. 13, 1938; Part II, Aug. 27, 1938.

(III-5) *A Report on Industrial Research as a National Resource—Introduction* by Raymond Stevens, vice-president, Arthur D. Little, Inc.; Section 1 of *Research—A National Resource*, II *Industrial Research* Dec. 1940.

Rebuilding the Boeing Stratoliners

By **WELLWOOD E. BEALL**, *Vice-President, Engineering, Boeing Aircraft Co.*

Revealed here are the engineering details of revisions being made in these well-known airliners recently returned from war service—how they are getting Flying Fortress wings, engines, and many other key parts in readiness for new commercial service.

THE BOEING STRATOLINER built in 1939, was the first four-engine transport with a supercharged cabin. Flown thousands of miles over transcontinental and transocean routes, it was the only long-range high altitude transport in operation.

When this country entered the war, an urgent need arose for airplanes of long range and proved reliability which the Air Transport Command could use to transport high ranking Army officials and important cargo to battle zones. Stratoliners owned by Transcontinental & Western Air were among the types the Army was looking for and accordingly they were taken over for this important transport work.

The first Stratoliner flight made in Feb. 1942 from Washington, D. C., to Trinidad, Brazil, the African Gold Coast, Cairo, and return, initiated ATC's transocean service. In the next two years the five Stratoliners made 3,000 ocean crossings for a total of 7,500,000 miles, flown in 44,911 hr.

Upon the return of these planes for domestic service last year, it was found that they were in need of structural reconditioning. The hard military use to which the planes had been put left scars on parts of the structure. The body structure was in excellent condition although the repeated coats of camouflage paint were peeling badly. The wings, however, were considerably more battered, and examination revealed that a structural overhaul by disassembly and replacement of damaged parts would be necessary.

The basic structure of the Stratoliner was almost identical with that of the B-17B Flying Fortress constructed at about the same time, and it was decided that the wing of the latest model Fortress, the B-17G, could be adapted for use on the stratoliner with a minimum of rework. In addition, there were other changes which could be made to advantage at the time of the wing change, and which would improve the flying characteristics of the airplane. These improvements would include complete new wings, horizontal tail surfaces, new engines and propellers, and landing gear.

Reconversion work on the first of the Stratoliners, incorporating, in addition to the major changes, many aerodynamic and mechanical features developed on the Flying Fortress, now has been completed and successful test flights made.

The new Stratoliner has the B-17G wing, slightly modified. This wing, full cantilever in construction with two main spars, hydropressed sheet leading edge ribs, and combination formed tubular interspar and trailing edge ribs, is similar in design and construction to the original Stratoliner wing. Whereas the initial Stratoliner wing employed 24SRT aluminum alloy for spars and compression ribs, the new wing all structural tubing is 24S aluminum alloy.

Attachment facilities and many changeability features of the B-17G wings are the same as those on the initial Stratoliner. The wings are modified to the extent of fitting the original Stratoliner wing tips and outer wing leading edges.

Wing flaps of the revised Stratoliner are those designed for the B-17G. Electrically controlled and of the trailing edge type, they have a downward as well as a downward movement. All operating mechanism and hinge supports for the flaps are contained within the wing contour.

The Frise-type counter-balanced ailerons, also B-17G parts, have the same physical characteristics as those of the original Stratoliner. The left aileron includes, at its inboard end, a metal trim tab operated by irreversible locking controls.

Fuselage of the Stratoliner is made up of the conventional circular formers and longitudinal stringers covered to Alclad sheet to form the semi-monocoque body structure. Except for changes required by the installation of the new tail landing gear and the horizontal stabilizer revision the contour and structural design of the Stratoliner fuselage is identical to that of the original airplane.

Structural changes required for the installation of the new tail landing gear and for the attachment of the new horizontal stabilizers were more extensive than for the attachment of the new wing. The B-17G stabilizers have considerably more area than those of the original Stratoliner and are attached at the same point on the rear spar of the fuselage. These changes called for a revision of the body bulkhead to which the front spar of the stabilizer is attached, revision of the bulkhead which acts as an attaching point for the rear spar, and addition of a new bulkhead aft of this to support the stabilizer hinge support beam. Several circumferentials and longitudinal stiffeners in the body tail section were added to provide necessary strength.

A revision also was made in the body tail cone and fairing with the addition of 24 in. to the monocoque structure. Skin patches around cut-outs for the elevator and rudder torque tubes also were added.

The elevators, also of B-17 design, made necessary the change in the torque tube location through the body, since the larger stabilizer placed them farther aft.

Vertical tail surfaces of the revised airplane are those of the original airplane, with the exception of the rudder torque tube, which is assembled with fairings at the body skin line.

Main landing gear has B-17G type struts, braces, and retracting screws, wheels from the original plane, and wheels, tires, tubes, and brakes similar to those used on the initial model. In order to accommodate the increased loads that would be imposed on the structure by the higher gross landing weight of the airplane—54,000 lb as compared to 45,000 for the original Stratoliner—the tail gear thrust brace channel members, shear ties, and joints were strengthened.

Normal retraction of the main gear is electrical, with an emergency manual retraction system operable from the accessory compartment in the body. An emergency air brake system, including a pressure storage bottle and a metering valve located in the fuselage, is connected to shuttle valves mounted on the brake.

The tail landing gear treadle is similar to the assembly originally used, except that B-17G tires (26 in., smooth contour), tubes, wheels, knuckles, and axles are installed. The upper frame and retracting screw were strengthened, and the wheel well was increased in size to accommodate the new wheel.

The engine nacelle accessory cowling and engine mounts of the new Stratoliner are reworked from B-17G assemblies. All unused openings are closed, and the firewall is revised where necessary to accommodate differences in power plant equipment and to provide passage for additional controls. The engine cowls installed on this airplane are B-17G assemblies with hydraulically operated flaps, the latter controlled by "open-close" valves on a panel in the cockpit.

New Stratoliner engines—9-cyl Wright Model GR-1820-G205A with a rated takeoff power of 1,200 hp.—are supported by B-17G Dynafocal shock mounts with accessory installations substantially the same as on the original Stratoliner. Installation of the new engines necessitated removal of all turbosupercharger installations, carburetor and intercooler ducts, air filters, and all pressure and intake ducts in the B-17G wing. One duct inboard of each inboard nacelle was left to provide air to the cabin. Carburetor air intakes and heaters, similar to those used on the original airplane, are installed.

The supercharging equipment was removed, and all plumbing and ducts as well as the controls in the wing were adjusted to conform with the engine installation. Fire protection is essentially the same as for the B-17G airplanes, except that the CO_2 fire extinguishing system connects to a carburetor air intake nozzle.

Propellers are three-blade Hamilton Standard hydromatic propellers of 11 ft. 6 in. dia. They provide fast feathering—from full "low pitch" to the "feather" position in 20 sec. or less. The propeller controls remain the same as those of the initial Stratoliner.

Oil tanks of B-17B design, with a total capacity of 180 U. S. gal., are installed in the nacelles of the new craft. The system is equipped with 11-in. dia. B-17G type oil cooler with integral surge valves.

An oil dilution system is provided,

First of Boeing Stratoliners undergoes revisions at Boeing plant after being returned from war service to TWA, which proposes to use them on European run when and if CAB grants certificate. Major point in reconversion to peace time role was installation of B-17 Flying Fortress wings, engines, and landing gear. Ship is seen here as power plants and undercarriage were getting final touches.

with the oil solenoid valve located aft of the firewall and with the fuel take-off between the booster pump and the engine pump. The rest of this system is the same as the B-17G.

Each wing of the new Stratoliner contains two engine fuel tanks and one feeder tank. These are of non-metallic design, and combined they have a minimum total capacity of 1,800 U. S. gal.

Provisions are incorporated in each wing for a fuel-dump system serving the forward outboard (main) tank and the inboard tank. This system includes an hydraulically operated tail pipe actuator, controlled from the cockpit. The rearranged fuel supply system includes strainers, shut-off valve, two-speed booster pumps, engine pumps, flow meters, and liquidometer fuel gages. No auxiliary fuel tanks are provided in the outboard wing panels. Fuel transfer between any tank in the airplane may be accomplished with the booster pumps and four fuel selector valves, two in each wing leading edge, which are connected by a cross line between wings.

Because of these changes, a number of new instrument installations were required. Electric tachometers and direct-reading manifold pressure gages were installed. Liquidometer fuel quantity indicators and fuel quantity transmitters replace Autosyn fuel level indicators. Autosyn type fuel flow meter gages are also installed. B-17G type fuel and oil pressure gages are installed, as well as B-17G oil temperature gages.

Autosyn instruments originally operating from 60-cycle electrical energy are replaced by 400-cycle instruments, while other instruments remain the same as originally.

Flight controls of the new Stratoliner are substantially the same as those used in the original airplane, although the elevator system was reworked to bring the "no-load" [illegible] down to current standards. This was done by increasing the diameter of the initial pulleys in the system and by removing the servo units. Rudder and tab controls are reinstalled in the [illegible] tail section to conform with the [illegible] nage revision. Engine and aileron controls are modified to accommodate the revised power plant installation and B-17 wing.

The electrical system of the [illegible] Stratoliner is a 24v [illegible] grounded return type. The [illegible] power source consists of three [illegible] ump generators in parallel with [illegible] quate wiring. Generator relays, [illegible] meters, voltmeter, and a [illegible] switch are included in the circuit. [illegible] exterior power receptacle for [illegible] operation is connected to the [illegible] through a relay. Two storage [illegible] ies of the type used in the B-17 [illegible] plane are connected to the main [illegible] lus through relays.

Power supply for the 12v [illegible] equipment is derived from the [illegible] power bus, and it incorporates a vol[illegible] age regulator of the carbon-pile [illegible] adjusted to the desired valve.

The starter system is identical [illegible] that of the original airplane [illegible] that induction vibrators are used [illegible] place of the former booster coils.

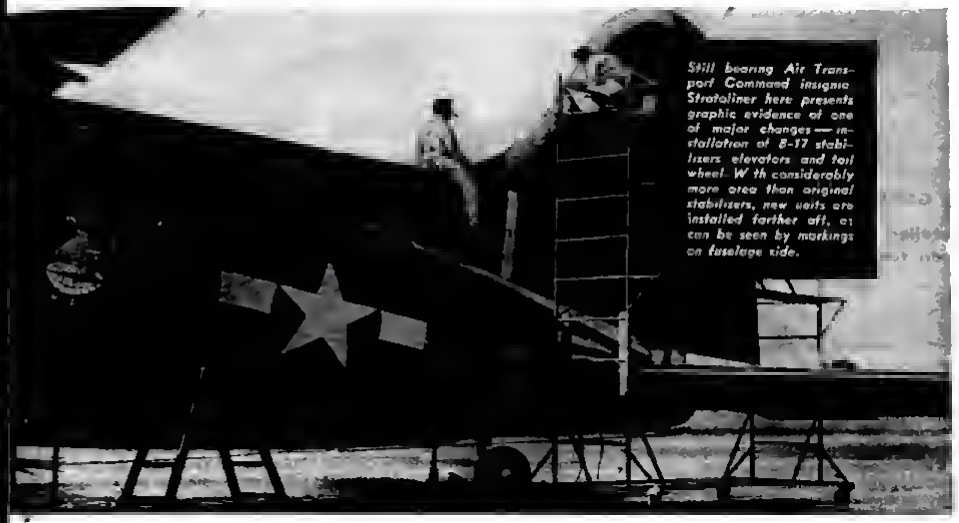
Alternating current is supplied [illegible] two 400-cycle inverters operated alternately. These inverters supply [illegible] power to the central buses, one [illegible] which is 115v, and the other 26v. [illegible] voltmeter and switch are provided [illegible] indicate the voltage at both the 26v [illegible] the 115v. taps.

Each engine is provided with a [illegible] flow-meter having a capacity of [illegible] 1000 lb. per hr. Fuel quantities pass[illegible] ing to each engine are shown on [illegible] instrument panel by two dual [illegible] ors, operating on 26v, 400-cycle a.c.

The two-speed electrical fuel [illegible] pumps installed on the main and [illegible] board tanks are controlled by [illegible] in the cockpit which operate from [illegible]

Contour and structure of fuselage in reconverted Stratoliners generally remains same as on original craft, principal changes between wing and fuselage being in ducting, wiring, and controls to fit new wings, engines, and landing gear.

• Following initial test flights of the re-built Stratoliners, R. C. Loomis, TWA engineering supervisor, reported that "the stability of the Model 3078 is greatly improved over that of the Model 3078 [the designation before re-conversion]. The static and dynamic stability is more positive throughout the CG range from 20 percent MAC to 26.5 percent MAC. This means that the pilot reaction will be more favorable, and the utility of the airplane will be greatly improved."



Still bearing Air Transport Command insignia, Stratoliner here presents graphic evidence of one of major changes — installation of B-17 stabilizers, elevators and tail wheel. With considerably more area than original stabilizers, new units are installed farther aft, as can be seen by markings on fuselage side.

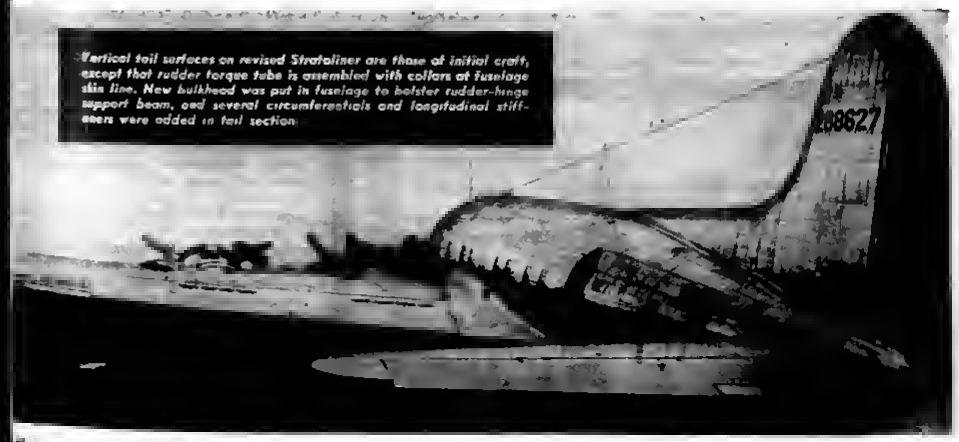
[illegible] direct current power source. Rewiring of the retracting motor circuits is carried out to conform with the revised landing gear operating system. Landing gear safety switches are installed so that retracting of either [illegible] wheel is prevented, unless both wheels are off the ground.

External lighting circuits are modified to accommodate sealed-beam landing lights, which are controlled through relays rather than by direct switching, and there is a separate courtesy light.

Leading edges of the principal flight surfaces on the new airplane are deiced in the same manner as on the original airplane, and the same equipment is employed, except that B-17G de-icer boots are used on the new surfaces. Propeller and carburetor anti-icing is provided as formerly, but tubing connections at the body-wing joint are revised to suit the new wing installations. The tubing in the aft end of the fuselage is relocated to conform with the change in the tail surfaces.

With these revisions and improvements, we feel the new Boeing Stratoliners now rate with the best of the transport planes available today for commercial use. A good plane has been made even better.

Vertical tail surfaces on revised Stratoliner are those of initial craft, except that rudder torque tube is assembled with collars at fuselage skin line. New bulkhead was put in fuselage to bolster rudder-hinge support beam, and several circumferentials and longitudinal stiffeners were added in tail section.



Determining Bend Radius —Via Analytical Approach

By **GEORGE GERARD**, *Senior Research Engineer, Republic Aviation Corp.*

Detailed here is a useful method for ascertaining minimum bend radii for new materials and for establishing test procedures.

EXTENSIVE use of aluminum alloy sheet in aircraft structures is based upon ease of formability of the material as well as its strength-weight advantage.

Commonest of all forming operations is the simple bend, which has wide application in structural elements throughout the plane. Stringers and longerons employ bends almost exclusively; straight flanges provide stability in unsupported regions of light gage members.

The structural efficiency of these components depends to some extent upon the smallest bend radius that can be employed successfully to form the part. A small bend radius on a light gage stringer or longeron will increase the crippling strength of the section, since the buckling strength of each element in the cross-section is a function of the end fixity provided by the radius. Similar conditions are encountered for flanged members. These considerations indicate that minimum bend radii have an important rôle in practical elastic stability problems.

Most minimum bend radii for materials in common use have been determined by trial-and-error method. Tests conducted in the shop yield results which are analyzed for consistency. The smallest bend radius for the material thickness at which 100 percent consistency is achieved is usually taken as the minimum value for the particular sheet gage tested.

Recently, the general subject of formability has been treated objectively and the literature overwhelmingly indicates the usefulness of an analytical method.[1, 2] Resolving of forming problems into basic elements in stress analysis, coupled with the science of metals, has resulted in a rational approach to these problems.

It is realized that sheet metal forming is a problem of a highly practical nature, yet an understanding of material properties under the stress conditions imposed in forming is essential if efficient use of the material consistent with an accurate stress analysis is to be realized.

The method of analytical approach to the problem of minimum bend radii has proved valuable in predicting such radii for new materials and for establishing test programs. The empirical data required can be readily obtained in the laboratory, and the evaluation of the data is simplified by use of a nomographic chart.

Bend Radius Problem

Principal parameter involved in bending is the ductility of the material to be formed. In tables of material physical properties, elongation in a 2-in. gage length of a standard tensile specimen is given as a measure of ductility. While the true value of this measure is subject to debate, the simplicity of the concept makes it readily employable in the bend radius problem.

Validity of applying tensile test elongation data to bending problems is widely supported.[1, 2, 3] It is generally assumed that the stress-strain condition imposed in forming a bend is identical to that existing in pure tension if the material has not previously been subjected to appreciable unidirectional cold working.

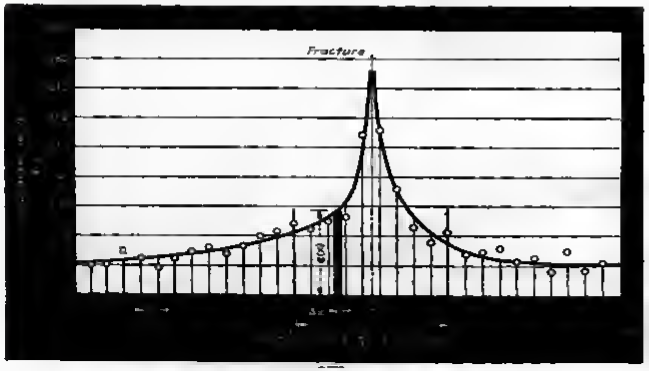
Use of tensile test data is further justified by the consideration that a bend failure is characterized by cracking which initiates at the outer surface, an obvious tension failure of the outer fibers.

The length of metal subjected to strain in bending, which is a function of the radius and angle of bend, is referred to as the bend gage length. F. R. Shanley[1] and Wm. Schroeder[2] show that bend gage lengths are considerably less than the standard tensile specimen gage length of 2 in., and that greater elongations are encountered in these short gage lengths.

The latter condition can be readily appreciated if elongation is considered to be composed of two phenomena—the very great local elongation on each side of the fracture, and the much smaller uniform elongation throughout the gage length of the material remote from the fracture region. This is evident in Fig. 1. As smaller gage lengths are considered, the local elongation in the fracture region becomes a greater part of the total, and consequently

[1, 2] (All references are collated at the end of this article, page 155)

Fig. 1. Graph showing typical strain distribution.



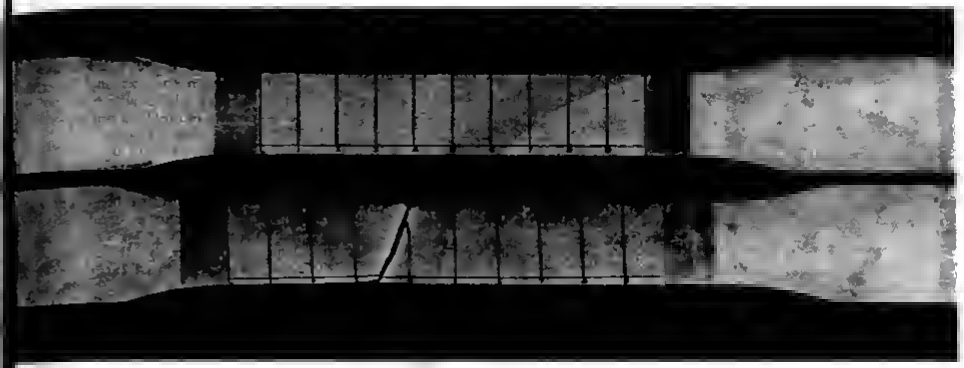


Fig. 2. Tensile specimens with grids reproduced on reduced sections.

...ter elongation values will result.

Requisite elongation data for the ... gage lengths of bends are obtained by employing the photo-grid technique.[5, 6] Briefly, the method involves reproducing a fine grid on the reduced section of a standard tensile specimen. The preparation of the specimens and photographic emulsion is amply detailed by G. A. Brewer and ... B. Glassco.[5, 6]

Fig. 2 shows two specimens with grids reproduced on the surfaces. The grid used in the tests was accurately drawn to a large scale and reduced to an over-all length of 2 in. The lines were 0.020 in. apart and approximately 0.002 in. wide.

Elongations in successive pairs of lines were measured along the centerline of the tensile specimen with the aid of a modified cathetometer. Data for a typical specimen are plotted in Fig. 1.

Test Specimen

Dimensions of the standard tensile specimens are those specified by ASTM. Usually, the specimens are cut cross-grain since this orientation is critical in bending. In addition, it was known that ultimate elongations for specimens so orientated were slightly lower than for with-grain specimens.

Elongation values in a given gage length have been found to increase with increasing sheet thickness. This variation is particularly noticeable in a small gage length as is evident from the following ultimate strains obtained for Alclad 24SO in a 0.15-in. gage length:

Sheet thickness (in.)	Ultimate Strain (percent)
0.025	28
0.040	33
0.091	40

To obviate testing various thicknesses of sheets, it was decided to test only 0.040 in. specimens and use these results in all calculations. Slight error is incurred for the range of formed sheet predominantly used, i.e., 0.025 to 0.064 in. material. In the heavier gages, the predicted bend radii are conservative and, thus, it would be desirable to test 0.125 in. specimens for accurate bend radii determinations in this range.

Ultimate Strain

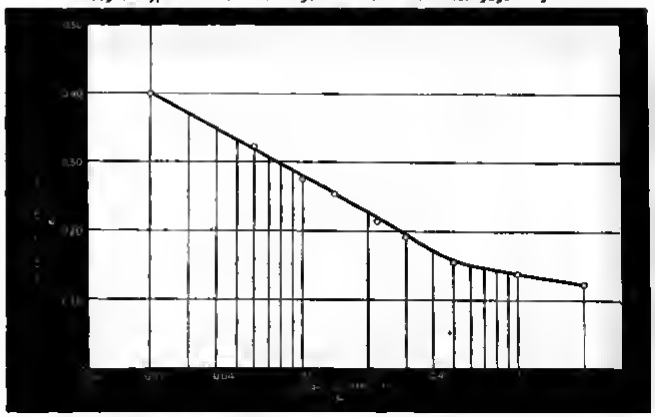
The local strain distribution over the tensile specimen constitutes the only empirical data required. In minimum bend radius calculations, these data are most useful when in the form of a curve of average ultimate strain versus gage length. Curves of this nature are derived directly from the strain distribution in Fig. 1.

The abscissa in this figure represents distance along the centerline of the reduced section of the tensile specimen. Therefore, any arbitrary length which includes the fracture is considered a gage length.

Reconsider Fig. 1. A gage length is so chosen as to include the fracture as the axis of symmetry. The ultimate elongation in this gage length is the area under the curve included between the two end points, $-x$ and $+x$.

$$e \approx \sum_{-x}^{x} \varepsilon(x)\,\Delta x \qquad (1)$$

Fig. 3. Typical curve of average ultimate strain versus gage length.



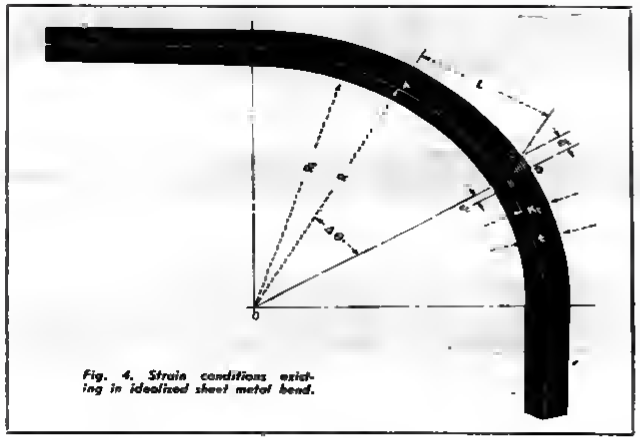


Fig. 4. Strain conditions existing in idealized sheet metal bend.

where e is the ultimate elongation, in
$e(x)$ is ultimate strain, a function of x, in./in., and
x is distance along centerline of specimen, in.

The average ultimate strain in this gage length L, is:

$$e_{ult} = \frac{\sum_{-x}^{x} e(x)\,\Delta x}{L} \qquad (2)$$

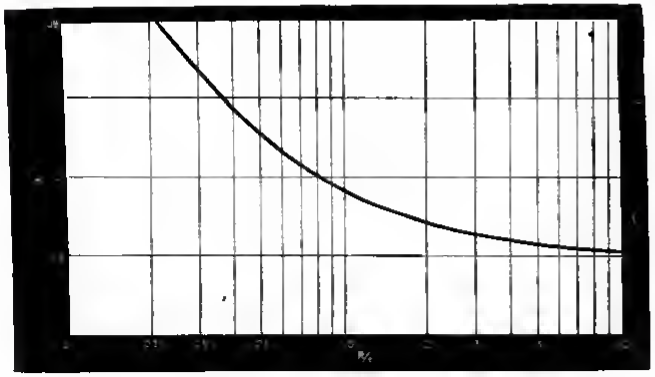
Thus, by choosing a number of different gage lengths, and performing the integration mechanically, average ultimate strain versus gage length curves (as in Fig. 3) can be derived for the material

Analysis of Bend

The strain conditions existing in an idealized bend are shown in Fig. 4. Certain basic assumptions are made at the outset which are identical to those of classic beam theory. The material is assumed to be homogeneous, and sections which were plane before bending are assumed to remain plane after bending.

This latter assumption has been shown to be approximately true far into the plastic range. Further assumptions, peculiar to this problem, are that the bend forms an arc of a circle and is formed under pure bending—that is, no external shear is applied.

Fig. 5. Graph showing neutral axis location in bend.



During the bending process, the outer fibers are elongated by the amount e_t (Fig. 4) while the inner fibers are compressed, e_c. The locus of points between the extreme inner and outer surface fibers which do not experience any elongation during bending defines the neutral axis.

For a cross-section of small curvature ($R > t$), the neutral axis is located almost equidistant from the two surfaces. Sections of large curvature ($R \to t$) have the neutral axis displaced toward the inner surface. Minimum bend radii, by their very character, are sections of large curvature and consequently there is an inward neutral axis displacement.

The length AB is taken at the neutral axis (Fig. 4) as a gage length. Then, from the similar triangles OAB and BCD, the following relationship is obtained:

$$\frac{L}{R} = \frac{e_t}{Kt} \qquad (3)$$

where L is gage length, in.
R, radius measured to the neutral axis, in.
e_t, elongation of extreme tension fiber, in.
K, ratio of distance between outer tension surface and neutral axis to thickness.
t, thickness, in.
ϵ strain, in./in.

Rearranging the terms of equation (3), and assuming that e_t has reached an ultimate value, leads to the ultimate strain:

$$\epsilon_{ult} = \frac{e_t}{L} = \frac{K}{R/t} \qquad (3a)$$

The factor K can be determined from curved-beam theory [5] by rewriting the basic equation for a beam of rectangular cross-section in terms of the symbols of Fig. 4. For large radii, the value of this factor is very nearly 0.5 i.e., the neutral axis is equidistant from the surfaces. For small bend radii, however, K becomes of some consequence. This is evident from Fig. 5 which depicts a plot of K versus R/t ratios.

In equation (3a), the ultimate strain ϵ_{ult} is equal to the ratio $K/(R/t)$. Values of this ratio are obtained from Fig. 5 by evaluating the secant drawn from the origin to the curve at various R/t values. Thus, this part of the equation is completely determined from curved-beam theory.

Since curves of average ultimate strain versus gage length have been empirically determined, it is merely necessary to find the bend gage length in order to determine the ultimate strain which the material can experience before a tensile failure begins. The gage length for any bend is a function of the radius, R, and the bend angle, Θ, in radians. Hence, from Fig. 4

$$L = R\,\Theta \qquad (4)$$

Thus, all the unknowns are found from the geometry of the bend. For a given radius and bend angle, the gage length is determined from equation (4) with which the average ultimate strain of the material is obtained from Fig. 3. Equation (3a) states the relationship between ultimate strain and R/t ratio. Therefore, using this strain value, the curve of $K/(R/t)$ versus R/t yields the corresponding R/t ratio. With the latter value, and the bend radius which is assumed at the start, it is a simple matter to find the maximum sheet thickness.

Nomographic Chart

The nomograph of Fig. 6 has been designed so that all the foregoing calculations can be performed rapidly. For a given radius and bend angle, the maximum sheet thickness can be simply determined by following the operations indicated on the nomograph. For subsequent use of this nomograph with other materials, it is merely necessary to plot on this chart the average ultimate strain versus gage length curve of the material.

It is evident that the method is one of trial-and-error, since the minimum bend radius for a given sheet thickness can only be found by assuming values of R and then finding a corresponding t. This is not particularly a drawback to the method, since one usually attempts to predict minimum bend radii for an entire range of sheet thicknesses. Nomographic solutions for several values of R will permit a plot of radius versus maximum sheet gage. For a particular sheet gage then, this curve will yield the proper *minimum* bend radius.

In the original analysis, the radius was chosen to the neutral axis of the bend. For production, the inside radius, R_i, is required and, therefore, the radius found on the nomographic chart must be corrected. The inside radius is smaller than the neutral axis radius by the distance between the inside fiber and the neutral axis. This relationship is expressed by:

$$R_i = R - t(1 - K) \qquad (5)$$

R and t are known, and K can be found from Fig. 5 for the corresponding R/t ratio.

Consistency of Results

The degree of success of the method is contingent upon the consistency of the empirical data. Good agreement has been obtained between theoretical results and shop bend radius tests when material from the same sheet has been used both in obtaining ultimate strain data and in the bend tests. However, once strain curves have been established in the laboratory for a given material, some degree of inconsistency may be anticipated for the material received in the shop.

Influence of grain size upon elongation is shown by G. A. Brewer,[3] and it is felt that this parameter is a governing factor in causing variations in ultimate strains for different specimens of the same material. Limits of grain size variation can be established for as-received sheet, the condition in which forming operations are usually made, by taking several specimens from different sheets of the same material to obtain strain data. A statistical approach should finally indicate the proper ultimate strain versus gage length curve to be used for a desired degree of consistency.

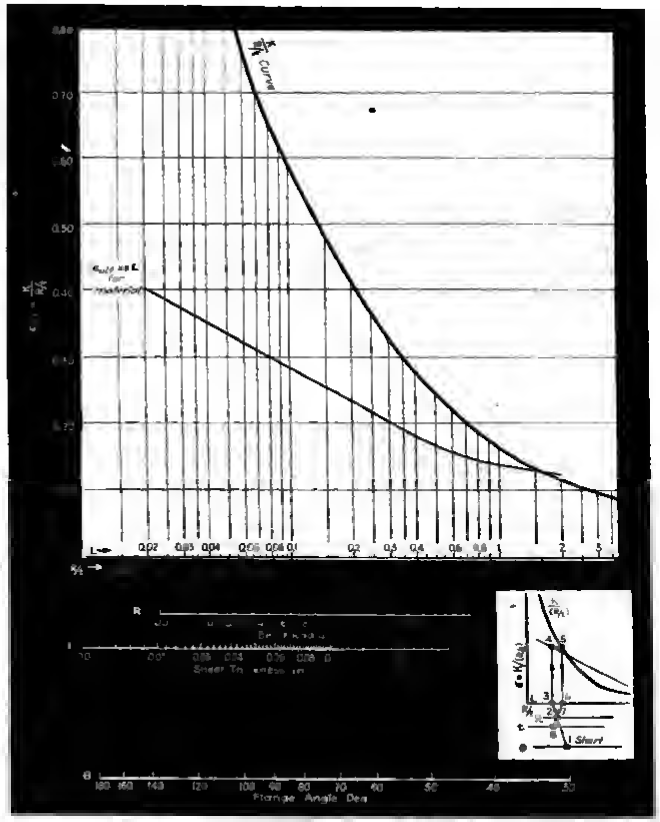


Fig. 6. Nomograph for determination of minimum bend radii.

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(5) *Strength of Materials*, Vol. II, p. 70, by S. Timoshenko, Van Nostrand, New York, 1941.
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Design and Operation Of FW-190 Gear Retracting Unit

By **CHESTER S. RICKER,** *Detroit Editor "Aviation"*

Unusually compact—measuring only 8⅝x13½ in.—it has over-all reduction of 10,500 to 1. And special design eliminates gear cutting so that production can be accomplished with grinder, lathe, and drill press.

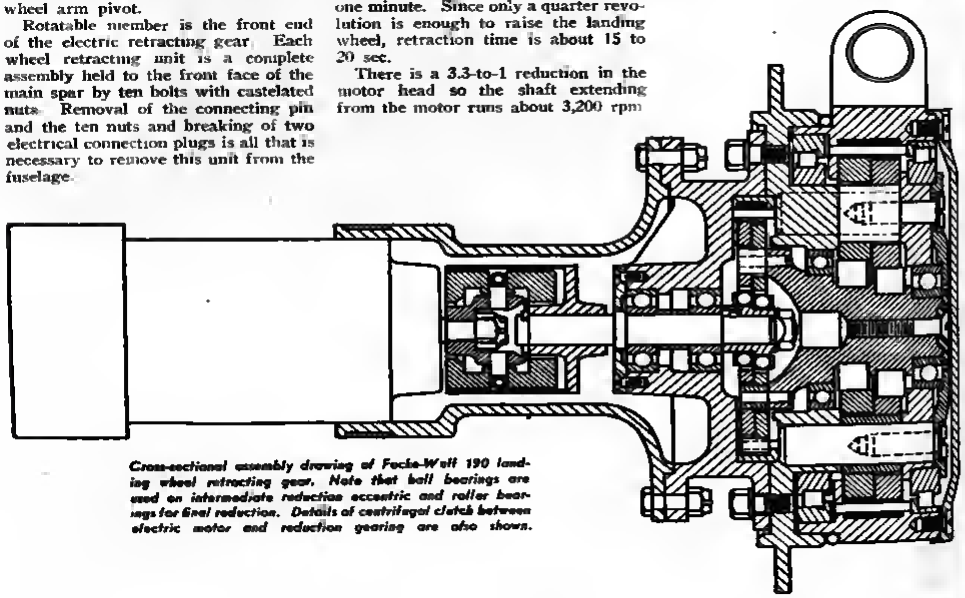
THE FOCKE-WULF 190 has independently operated main landing wheels, each of which is carried by an arm pivoted at right angles to, and mounted on, the front main spar. It is held in landing position by a hinged link securing the wheel by a toggle action when down.

Upper half of the hinged link is secured to a rotatable member by a fork and pin joint, and the axis of this member is approximately parallel to the wheel arm pivot.

Rotatable member is the front end of the electric retracting gear. Each wheel retracting unit is a complete assembly held to the front face of the main spar by ten bolts with castelated nuts. Removal of the connecting pin and the ten nuts and breaking of two electrical connection plugs is all that is necessary to remove this unit from the fuselage.

Outstanding features of the retractor are its compactness, light weight, and unusual method of getting a very high gear reduction in a small space. The unit, including the motor, measures 13½ in. in length and 8⅝ in. over the mounting flange. There are only three reductions needed to give an over-all of 10,500 to 1 from armature shaft to the rotating head. With a 10,000-rpm. 27v. motor this means a full rotation of the operating head in one minute. Since only a quarter revolution is enough to raise the landing wheel, retraction time is about 15 to 20 sec.

There is a 3.3-to-1 reduction in the motor head so the shaft extending from the motor runs about 3,200 rpm.



Cross-sectional assembly drawing of Focke-Wulf 190 landing wheel retracting gear. Note that ball bearings are used on intermediate reduction eccentric and roller bearings for final reduction. Details of centrifugal clutch between electric motor and reduction gearing are also shown.

On this are mounted two cast iron shoes, driven by a cross-pin and held in place by a continuous coiled spring band. The latter is stiff enough to hold the shoes in place and to resist centrifugal force so as to allow the motor to attain considerable speed before the shoes engage a surrounding drum of steel. This gives an automatic clutch effect.

The drum is attached to the intermediate reduction mechanism. Giving a final over-all reduction of 3,180 to 1, the last two mechanisms are compacted into a space of 4 in. axially and of 7½ in. dia. Both reductions are also coaxial with the unit, and the casing head rotates in the final reduction. Apparently no standard spur gear train of equal ratio could be crowded into this small space.

The two last reductions, while of the same type, are attained without gears of the tooth type, instead being enabled through shallow scallops ground in the edge of hardened steel disks and engaging hardened steel sleeves that float on pins fixed in the surrounding housing.

Principle employed is similar to that sometimes used with toothed gears where an internal gear meshes with a spur gear having one or more teeth less than the internal gear, the spur gear being oscillated by an eccentric at its center, but prevented from rotation by a pin. The axis of the eccentric shaft must be coaxial with the internal gear. Then for each rotation of the eccentric shaft the internal gear will be advanced one tooth by the spur gear. This design was used at one time for operating variable pitch propellers.

Only difference between the above gear reduction and that of the FW-190 design is that in the latter the gear teeth are eliminated from both members. The aforementioned semi-circular scallops ground in the edge of the disks replace the spur gears, and the internal gear teeth are replaced by the pins on which the hardened steel sleeves are mounted.

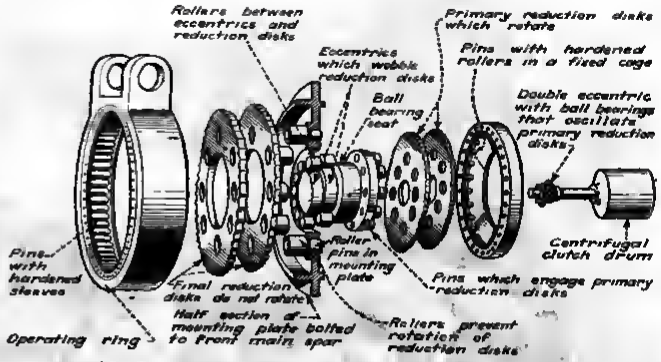
In each reduction two disks are used so as to give a continuous drive at all times. The eccentrics are also arranged diametrically opposite one another so as to keep the two disks balanced when running.

Another unusual feature of the design is the operation giving the two reductions. For the intermediate one, the outer member is secured so that the oscillating disks rotate slowly, making one complete rotation every 53 oscillations.

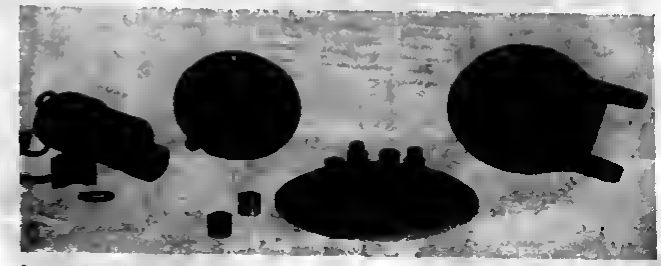
Eight pins engage these oscillating disks and thus rotate with them. These pins are mounted in a flange on the end of the eccentric shaft to give the final reduction. The latter reduction mechanism is mounted on the flanged forging which supports the entire reduction gear and is bolted to the front main spar. On this member are eight heavy sleeved pins that pass through the final reduction-oscillating disks and prevent them from rotating. Therefore they force the internal gear or retracting gear head which encloses them to rotate one turn for every 60 oscillations of the disks.

The head is the member which is pinned to the arm that lifts or lowers the landing gear. To take the lifting load, the outside member is carried on two roller bearings located on each side of the internal gear pins. These bearings have 64 rollers, ¼ x ¼ in.

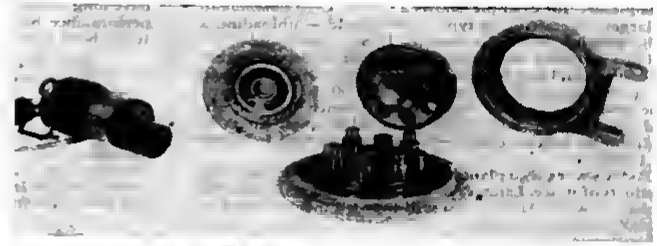
Outer member is held in place endwise by a plate secured by eight cap screws engaging the pins used in attaining the final gear reduction. A cover plate attached to the front of the rotating outer member encloses the entire mechanism.



Exploded view of operating mechanism of Focke-Wulf 190 landing wheel reduction mechanism. Housings have been omitted for clarity.



Parts of Focke-Wulf 190 retracting gear. At left is electric motor with half of centrifugal clutch and its retaining spring removed. Next is housing containing intermediate reduction mechanism. Clutch drum is clearly shown on this unit. In foreground is mounting plate with its stationary pins, which carry hardened steel sleeves, two of which have been removed. At right is final reduction head with operating fork. Retainer plate hides oscillating members. This plate, mounted on stationary pins, carries a ball bearing to support outer end of eccentric shaft. (AAF photo)



Reduction mechanism of retracting gear. At left are oscillating disks of intermediate reduction; center, final reduction oscillating disks, with flanged eccentric shaft carrying pins which engage intermediate reduction disks; right, pin and sleeve internal gear mechanism that is attached to wheel lifting arm. (AAF photo)

Design of the mechanism eliminates gear cutting by enabling processing of the parts with a grinder, lathe, and drillpress.

Maintenance executives of Northeast Airlines. Left to right: General Maintenance Engineer E. J. Spicino; Asst. Supt. Modification & Overhaul R. E. Bean; Vice-President of Maintenance & Engineering Howard D. Ingalls; Supt. of Maintenance W. C. Bowman; and Asst. Supt. Maintenance R. F. Cataldo.

"Perpetual Overhaul" Overcomes Plane Shortages

By **HOWARD D. INGALLS,** *Vice-President, Maintenance & Engineering Northeast Airlines*

The baffling problem was: "How can we keep our planes flying 18 hr. a day every day—and continue to maintain full overhaul on them at the very same time?" . . . The enterprising answer was: "There are still 6 hr. left in each day, so we'll do it." And they did.

WHEN AN AIRLINE, despite being cutback to a mere two aircraft, still continues to perform the daily miracle of maintaining 3,128 mi. of passenger, airmail, and express schedules—it has certainly solved a knotty problem, to say the least.

The No. 1 puzzle was: "When shall we take one of these two airplanes out of schedule for complete overhaul?" And No. 2 was the enigma: "Just how will the other single plane keep the business going?" For an airline, like the theater's tradition as to the show, must go on.

The above brain-wracker's constituted the problem which, not long ago, confronted Northeast Airlines, Boston-based, with routes through Massachusetts, Maine, New Hampshire, and Vermont to Canada.

The government, as all airlines and many travelers remember, had found itself urgently needing transport planes and was obliged to help itself to a large percentage of those the airlines used. And accordingly Northeast Airlines was left with two planes.

Part solution to the problem was the discontinuing, as a war emergency measure, of the Boston-Montreal route, which effected a shrinkage of the daily route mileage from 4,140 to 3,128, but it did not answer the question as to how each aircraft could be kept in service 18 hr. per day. Whether the chronology is figured in Eastern War Time, Atlantic War Time, Greenwich Mean Time, or combinations thereof, there are still no more than 24 hr. in any one day.

Thus, through troubles born of the war and the shortage of Douglas DC-3's, came Northeast's need for a special plan—namely a tight routine of perpetual inspection and overhaul between flights.

Left: Progressive overhaul chart originated by Northeast Airlines for use in perpetual overhaul.

The idea came to the writer some years ago when he was chief engineer in charge of maintenance for an airline being developed to link Miami, Panama, Port au Prince, Port of Spain, Natal, Rio, Buenos Aires, and Santiago. Briefly, the theory was this: That if circumstances do not permit an aircraft to be taken out of schedule for a complete overhaul, it might yet be practical to do the whole job, piece by piece, in those hours during the day's 24 when the aircraft is inoperative for the longest time. This, literally, was the plan put into operation by Northeast—and it worked.

In the aforementioned Miami-South American operation, the plan had been employed as something of a test. The only locations at which the large Consolidated Commodore flying boats could be beached were at Miami and at Buenos Aires. It was impossible to dismantle an aircraft at one time for complete overhaul; and even had this been possible, sufficient equipment was not on hand to permit complete overhaul without missing schedules. There were also the problems of tools, competent personnel, differences of foreign customs, and delays. Also, Latin American nations called upon the airline to use a large percentage of inexperienced native help.

A Two-Plane Airline

At any rate, Northeast's problem proved similar, and even more acute. Shortage of equipment left the airline with only two aircraft to care for a full 18-hr. schedule daily. It was out of the question to take "time out" to put either airplane into the hangar for a complete inspection and overhaul.

The writer then brought up the proposal of perpetual overhaul, relating his experiences in experimenting with it to the maintenance staff, the CAA, manufacturers, and company officials.

It was agreed that a period of perpetual overhaul could be designated without taking the aircraft out of service or delaying schedules, and at the same time possibly effect better maintenance by progressive overhaul, with a portion of the work done on the plane one day and another portion the next.

Here one very important condition developed. If the aircraft were to be taken out of service for several days in order to accomplish the overhaul completely in a minimum of time (as is the procedure with many airlines) Northeast would have to hire and set up a special organization to enable the operation to be done under the best possible speed conditions. Then, after the job was completed, there would have to be an immediate curtailment of help. For the workers just hired (many of them would have to be trained) would have to be released, since there would not be sufficient aircraft to have one in the shop at all times. In this case the work would possibly lag, and utilization of the aircraft would be reduced.

As it is, the maintenance staff has an even work program covering the 6 hr. which are normally available for perpetual overhaul between each airplane's 18 hr. of daily assigned schedules.

If we were not accomplishing perpetual overhaul, the same amount of time (6 hr.) would be devoted to maintenance, line service, and inspection; but we would not utilize so many man-hours and, in the writer's opinion, would not enjoy such a high daily percentage of efficient maintenance.

In many cases where we remove a component part for inspection and overhaul, we find some other major part that needs immediate attention. The system at present calls for accomplishment of the overhaul service between 1 a.m. and 6 a.m. daily; and there is one additional factor, bad weather, which sometimes helps with one of the more complicated jobs. When a major item is to be overhauled, we request Operations to let us know in advance as to possible cancellation, so that the longer jobs may be done when the ship will be held on the ground anyway on account of weather. Our only problem is to schedule the specific aircraft we want to work on so that it is available at the Boston base.

Engine change is a separate problem, but it falls into the schedule as might any other item. In order to have the engines ready for a change without a schedule delay, the replacement power plants are built up and held ready for installation. We stagger engine changes by doing only one replacement at a time.

Actually both engines could be changed within the allotted time, but there again would be the problem of additional personnel of this particular type for only a short time. As it is now, we are able to change one engine and still have additional men to inspect, repair, overhaul, and modify the same aircraft.

Under our system, the airplane, for the purposes of perpetual overhaul, is classified into 14 components which break down to approximately 327 items. For example, landing gear consists of 15 items which have to be completely inspected, reconditioned, or overhauled under CAR and the manufacturer's recommendations. Other components run into a considerable number of items, particularly the electrical system and accessories, but each has its place in the program and is taken care of in turn under the simple perpetual system.

Whether this between-flights system of overhaul will be continued by NEA after the war is, of course, a question to be determined by the management. In view of the line's new certificates from the CAB, and also the extensive plans for new service throughout New England and elsewhere, it may be that the urgent need for planes, with the consequent need for this time-saving overhaul service, will continue for a considerable period.

It is largely a matter of whether you are going to have *spare* airplanes, or *enough* airplanes. Perhaps perpetual overhaul will come to be considered the equivalent of an extra airplane—one that didn't have to be ordered, waited for, and paid for. Even with enough airplanes to make it possible to roll one into the shop for a complete overhaul, there is something to be said for a procedure under which one uses perpetual overhaul instead, and thus has the extra ship as a stand-by, ready to go.

High Standards Retained

Perpetual overhaul provides good, daily maintenance, safety of operation, and economy, the standards being just as high as with any other system. It also permits personnel to work on all phases of maintenance such as line service, engine check, engine change, and overhaul of component parts. It must be kept in mind that in a small company, specialists are few, and good men must be able to accomplish different phases of work to keep the airline in operation. To which might be added the well established truth that even some large companies have known the day when they'd like a few more capable airplane and engine workers who are certificated by the CAA.

With the coming of larger airplanes—which brings up the housing problem and a long overhaul time during any one period—perpetual overhaul should become more popular in the future than it has in the past.

A factor which will encourage this type of overhaul is that the engine, aircraft, and accessory manufacturers have exercised a lot of thought in making all parts easy to service or replace. CAA was also most helpful in assisting us.

Perpetual overhaul is sound practice because the operator can reduce the number of aircraft in service by their greater utilization and also get most flying hours out of the equipment before it becomes obsolete. However it must be remembered that it takes very close cooperation between the CAA, the manufacturers, and the maintenance and engineering departments of the airline.

TOOLS AND TRAITS VS. TROUBLES

PART II OF A SERIES

By E. L. LINDSLEY

Emphasizing that "horse sense" and keen observation, backed by experience, are the main factors in the makeup of the successful "shooter", Author Lindsley follows up with a graphic chart to aid your mechanics in tracking down the true sources of troubles—operational or structural, general or local.

THE TROUBLE SHOOTER needs a thorough clean-cut knowledge of engines, accessories, and their installation—all carefully classified in a mind capable of identifying symptoms of trouble and their possible causes.

Though this may seem to be stating too much in these days of rapid design changes and complicated installations, it has been demonstrated, time and again, that a man with a clear, basic, electrical and mechanical knowledge will be able to approach nearly any engine and solve the average run of maintenance troubles.

About 95 percent of all successful trouble shooting is founded in "horse sense." Thousands of newly trained mechanics must have the feeling that their capabilities are pitifully small the first time they are "on the spot" to correct engine trouble, not remembering that the airplane engine is only a refinement of any four-stroke cycle engine, thus bearing kinship to the conventional power plants used in farm tractors or autos.

If an engine is properly timed, if it has compression, fuel, and ignition—it must run. When trouble occurs, the mechanic need only use his head. You may say to your mechanic: "Run out to the plane with your tool box . . . then sit on that tool box, don't open it . . . don't touch a thing, until you are sure you have carefully considered the symptoms of the trouble and their possible sources, until you are sure you have a plan that will enable you to eliminate one by one, the wrong possibilities, until the true trouble is identified—meanwhile not upsetting other items."

Before your mechanic inspects an engine, he should ask himself: (1) What are the most likely points of trouble in this engine and installation?, (2) who has been operating the engine—an experienced pilot, a careless pilot, or perhaps a student?, (3) what type of usage has the engine received— cross country, transport, instruction, or combat flying?, (4) what were the conditions of operation —cold or hot, dusty, rainy, or damp weather?

A mechanic who has worked on an engine knows that certain items are quite likely to fail before others, and that this is particularly true of minor parts subject to vibration. Fact that certain parts are rather lightly built is no reflection on the designers, because weight, of course, must always be held to a minimum in order that sufficient payload may be possible. Since it is more practical to make an airplane light enough to carry a good load, we must pay the price in maintenance, having employed parts which are light yet strong enough to carry their share of the load.

Thorough inspection obviates the many errors which can be caused by snap judgments when trouble source is sought. (AA photo)

Cowlings, oil and fuel lines, cooling baffles, engine mount bolts and shock mounts, sparkplug connections, harness wiring, pressure and temperature gage lines and hose clamps are light in construction and for that reason soon reflect the battering of the air stream of vibration, and of those old twins, expansion and contraction. But the majority of such parts are quite easily repaired and maintained in an airworthy condition. The common tools found in the mechanic's tool box, used following rigorous inspection and with normal skill, will usually take care of troubles in these quarters.

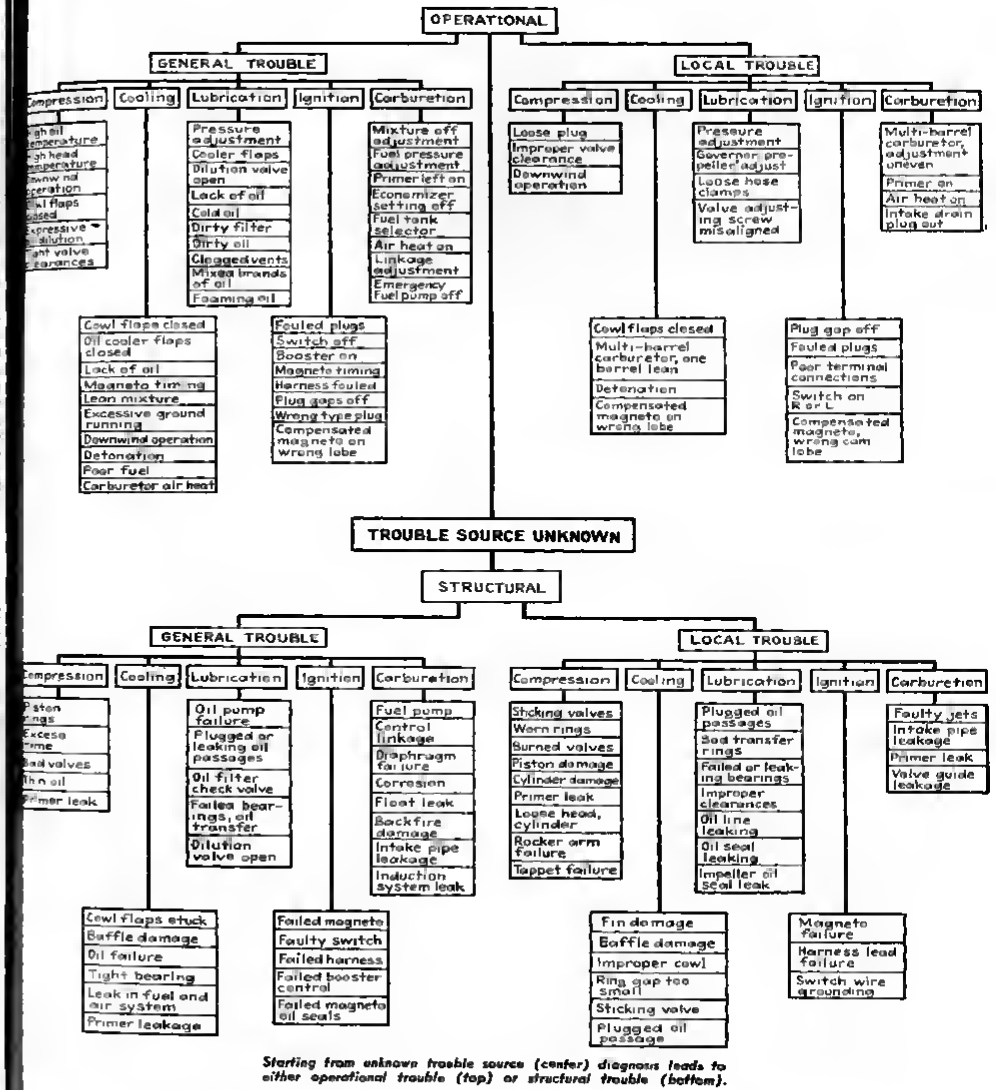
Engine History Is Important

Second item listed—who has been operating the engine—is too frequently overlooked. Some pilots have had engine-operating habits and are not aware that their technique falls in the class of engine abuse. A wise mechanic will observe a pilot's method of engine operation; if he notices some things that are not as they should be he may not make any comments, but he should inspect the engine frequently for such damage as he considers probable. If the mechanic knows, for example that the pilot is careless about opening cowl flaps or oil cooler shutters, he should pay more than usual attention to valves and piston rings. Oil consumption, exhaust pipe soot and compression checks will usually tell their story.

Student pilots are common offenders. For instance, a student who overshoots in landing quite often can crack cylinder heads and burn up valves when he uses full power to pull out of a tight spot. The long glide, with resultant low cylinder head temperatures, followed by sudden full power and a rush of hot exhaust gases has often caused cracked cylinder heads through unequal heating on opposite sides.

Most mechanics have, at one time or another, purchased a used automobile. This can be a very educational experience when, after initial operation, one learns in graphic fashion why the preceding owner sold the car. A frequent sales point usually runs, "This car was owned by a 60-yr-old school teacher, he never drove it over 30 mph." If this statement were true, one certainly would buy such a pampered car in preference to one suspected of being a repainted taxicab. Similarly, constant takeoffs and landings are much more detrimental to engine life than are long periods of cruising. Military operation in combat zones imposes on engines a more severe strain than anything encountered in commercial operation.

Lack of tools, shortage of time, men, or spare parts, and a multitude of other



Starting from unknown trouble source (center) diagnosis leads to either operational trouble (top) or structural trouble (bottom).

difficulties beset the engine mechanic charged with maintaining military aircraft. However, if it were possible to provide the ultimate in fine maintenance for combat engines, the facts concerning the sheer toctare of such operation would rrmain unchanged. As an example, operation of a plane at its maximum range involves adjustments of the mixture control in the lean range. A combinatioo of violent evasive action and critical mixtures might easily overheat the engine.

A seasoned mechanic who heard a pilot say, "Boy, I really had to lean her out to get back from this show," would in all probability make a careful check for symptoms of overheating. To such a mechanic the story is easily read in discoloration of head fins, burned sparkplug electrodes, loss of compression, deteriorated ignitioo wiring, and a simple check of flight hours versus fuel consumption.

A trouble shooter must always remember the type of usage his engine has received.

All mechanics who have maintained engines in northern latitudes are familiar with the effects of weather on engine operation. Terrain and airport characteristics are almost equally important. Moisture, salt air, sand, poor runways, improper shelter, cold and heat—all will take their toll of aircraft engines unless the mechanic is ever watchful of vulnerable items, and even then he must be sure of the preventive steps available to him. Obviously damage may sometimes result in spite of all efforts, for conditions may make ideal service impossible.

Preventive Maintenance

The preceding paragraphs illustrate some qualifications of the trouble shooter. Preventive maintenance affords an approach to engine troubles not yet manifested by actual malfunctioning. This preventive approach reverses normal trouble shnoting practice, for when speaking of trouble shooting, one usually implies actual existence of trouble, awaiting diagnosis and correction.

Analysis brings us to the well established breakdown of troubles, according to whether they are structural or operational, general or local. It might be well to refresh ourselves on the logic that has made this familiar breakdown so nseful and reliable. First, we may reasonably spht engine troubles into two classes: Structural failures and operational difficulties. Structural failures may be construed to imply all troubles that involve breakage or deterioration otber than through normal wear. Broken articulated rods or piston rings are examples of aucb

Ignition troubles often prove cause of rough engine. (CPA photo)

failures. Structural failure is usually quite easily detected either by inspection of oil sumps and strainers or by the engine refusing to run.

Operational trouble originates in improper adjustments or operation. Unless the nature of the trouble is such as to bring about serious engine damage, one can frequently correct operational trouble by readjustment or by a change in operating procedure. An example would be improper idle-mixture adjustment.

Thus, having set up the two basic headings, structural and operational troubles, we subdivide into general and local troubles. To illustrate: A fouled plug in the No. 1 cylinder constitutes an operational trouble of local nature in the ignition system. We say this because the misfiring is not a structural failure of the engine, it does not affect all cylinders, it is a malfunction of a portion of one of the power producing processes.

Poor adjustment of a carburetor compensator system may give a lean-mixture indication at high power outputs, that is, popping, high head temperatures, and lowered powec output for a given throttle opening. This, however, is another operational trouble. Since all cylinders are concerned, the trouble is general and a trouble sourec capable of producing a general trouble must be located.

If we subdivide our troubles once more, we may establish a chart somewhat like that accompanying this article. Most troubles may be isolated by applying the following test questions: Do the symptoms indicate a structural or operational trouble? Is the trouble confined to a single cylinder or group of cylinders? Is the trouble more inclined to be general than local? Which of the five systems under each heading (see cbart) appears to be involved? Other possible causes could often be listed by mechanics fully experienced on specific makes or models of engine.

There is at least one danger in using a breakdown of this type due to the difficulty involved in separating symptoms from sources. Example: The symptom might be overheating of the engine, the source might be lubrication, timing, or carburetion. Improvement of the cooling system through mechanical change or more careful operation would not correct the condition since it would be hitting at the symptom rather than the source. Plainly the usefulness of these charted breakdowns depends on the sound judgment of the mechanic. It is much easier to correct engine troubles on paper than in the airplane.

Three sources of information are commonly used to detect engine troubles: (1) Engine instruments, (2) operation of the engine with respect to fuel and oil consumption and all round reliability, and (3) the sensory perceptions of the mechanic himself. These three sources complement each other, and the indications of each must be weighed before a logical decision can be reached.

Let us examine, for a minute, one of our most common troubles—rough running. Our first report of the trouble may be from the pilot or line crew. It is not likely that any very specific informatioo will be given to the trouble shooter. The usual "Squawk sheet" comment, "left engine rough" suggests any number of possible causes.

Check-Run Advisable

The trouble shooter might like more specific comments, but even when they are offered, it would be good judgment, unless serious engine damage seemed likely, to cbeck-run the engine. No two people describe anything in exactly the same words, and the first rule of the aviation business is: "Never take anything for granted."

Our second source of information—instrument readings—will help us isolate the trouble. If an excessive drop in rpm is indicated when running on either magneto alone, the mechanic can be quite sure there's an ignition problem. If the ignition checks out properly, then he must look farther. A faulty propeller, sticky valves, or perhaps some more remote trouble source may be responsible. In any case he probably will have called on third source of information—the human senses—into play.

Most good mechanics are able to detect poor engine operation by listening to the engine. This applies, of course, only to the more obvious engine troubles. An automobile engine is more adapted to analysis by ear than is an airplane engine. In the first place, an automobile engine may operate quite smoothly and yet not be generating its full power. The car lacks its original "pep", but it is still drivable. An airplane engine, on the other hand, must continue to delivec its specified power right up to overhaul; if it fails to do this it is not airworthy, no matter how smooth it sounds.

High powered aircraft engines are not designed with any particular efforts toward extremely smooth low speed operation, the valve and spark timing, large cylinder volumes, and other features, are all intended to give full takeoff powers and economical cruising—for this reason we must operate at, or near, cruising power while we lend our ears to the engine's roar. However, propeller noise at such speeds over-rides engine sounds and it takes experience to sort out the various engine indications.

Each systrm of the engine, taken by itself, produces some sound; the exhaust is probably the most obvious and in its roar may be detected the proper or improper functioning of the carburetor, valves, pistons, and ignition system. Mechanical sounds are quite easily heard. It is possible to pick out the accessory drive gearing, the valve mechanism, or the whine of a generator, provided the would-be listenec is in the proper position and has the experience necessary to sort out the sounds. It is good to form the habit of listening sharply to all engines; if a mechanic does this concientiously he will soon find himself expert in distinguishing good or bad performance.

Seeing vs. "Seeing"

Sight is as useful as hearing in trouble shooting. Most mechanics possess reasonably good eyesight; but recognition, the main link in tbe chain, needs development. As an example, an unskilled man may see, in a physical sense, a wing surface with a sooty black swath extending back from the exhaust pipe; but his eye passes right on without mental impression. The mediocre mechanic notices the soot and, perhaps, makes a mental note to clean it off. A skilled trouble-shooter not only sees and recognizes the soot swath but also analyzes its meaning with regard to oil consumption, compression, and the engine's future usefulness. If he is in a position of responsibility—a crew chief, for instance—he probably makes a mental disposition of his men—first, a crew to investigate the trouble; second, a tentative place in his work schedule to allow the man hours necessary to change the engine, if need be.

Most maintenance men are familiar with the classic exhaust flame appearance for various mixture ratios and engine troubles. Unfortunately, these flames, so colorfully illustrated in engine manuals, do not appear so clearly at the end of a turbosupercharger exhaust system, neither are they readily visible in the bright sunlight of the airport ramp. Exhaust flames follow, moreover, the old saying that, "All cats are gray at night"; that is, flame color depends on light conditions.

The writer has seen two mechanics make their trouble analysis by watching exhaust flames oo opposite sides of the cowling. The man with his back to the sun saw nothing but a slight smoking, but the mechanic on the shady side noted torching and rich mixture flames. They concluded, therefore, that the cylinders on one side were receiving too much fuel, and they started searching for a source of improper fuel distribution, such as a leaking primer or perhaps leaking intake pipes.

After tinkering several hours, they ran the engine again—this time all exhaust flames indicated a rich mixture which they corrected with a few clicks on the carburetor adjustment. The joker, of course, was that now the dim twilight allowed the flames to show evenly on both sides, whereas the bright afternoon sun had given rise to a misleading flame appearance. Flames are useful only when viewed in a fairly dim and evenly distributed light, such as in an enclosed test cell, and then all exhaust stacks must be of equal length and fairly short.

Close observation of exhaust smoke is another story—frequently a revealing one. Rich, black smoke common to rich mixtures is a familiar sight to all who have watched bigh-powered planes take off. This is the result of fuel cooling as an anti-detonation measure and is not necessarily cause for alarm. Gray oil smoke is a more alarming symptom. Most radial engines throw a plentiful cloud of oil smoke when first started but this is caused by a natural drainage and collection in the lower valve passages and exhaust pipes, and it should burn out quickly.

A steady oil smoke in flight calls for a rigorous ground check, for it indicates worn or sticking rings, detonation holes in pistons, leaking impeller oil seals, or leaking valve guides—to name a few of the troubles. Oil smoke accompanied by oil spray, or smoke from the engine breathers, or an oil collection around the propeller dome breather outlet, is a strong indication of severe pistoo ring wear or a burned-through piston.

Occasionally an engine will exhibit a puffing oil-smoke discharge rather similar to a smoker puffing rapidly upon a pipe. This can be caused by very simple troubles, such as bad sparkplugs. However, it is also a symptom of sticking valves or broken or bent push rods.

Leaking impeller oil seals frequently give a first impression of worn piston rings by a steady smoking in flight, but a check of sparkplugs and compression will usually reveal the difference. Uneven compression and individually fouled plugs indicate bad rings, whereas generally fouled plugs and oil in the intake pipes indicate that leaking impeller oil seals are allowing oil to be drawn into the induction system.

Mechanics overlook one excellent source of informatioo if they fail to observe the soot deposits in the exhaust stacks. The writer has never seen a tabulation of tail-pipe soot colors with regard to engine conditions; probably there are too many variable factors involved for accurate tabulation. If, however, a mechanic will carefully observe the exhaust stacks of many similar installations, mentally note the eventual history of the engine, and coordinate these events with the appearance of the preceding exhaust deposits, he will find himself with a wealth of information that will enable him to predict engine operation with better than fair results under most circumstances.

Exhaust Stack Signs

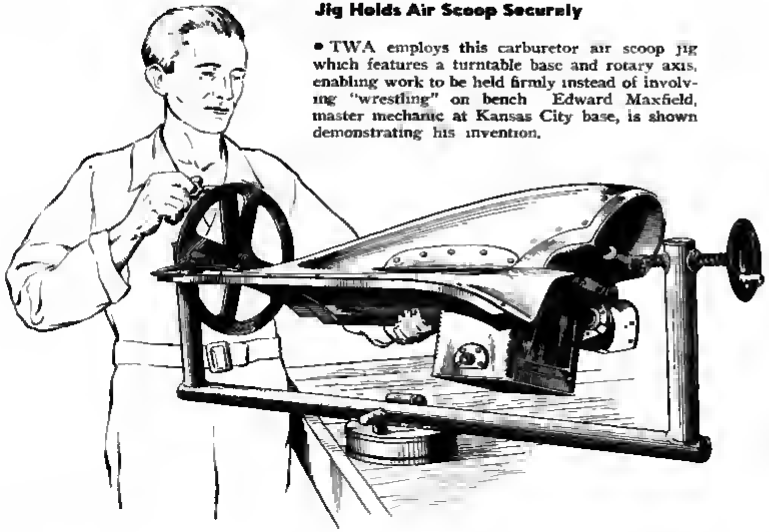
Some men are able to walk down the line and, with almost complete accuracy, point out engines that are about to fail, about to increase their oil coosumption, or otherwise malfunction. This is not far-fetched if the reader remembers the exbaust gas analyzer. Oil soot, carbon soot, lead deposits, white, red, and brown ash—all tell a tale much as the electrically analyzed exhaust gases tell of mixture ratios.

An unusually acute sense of touch is probably common to all mechanics. It manifests itself in proper tool manipulation, niceties nf handling and tightening—the ability to "see with his fingertips" when installing an accessory deep in the maze behind the engine. All mechanics know the trick of detecting a dead eylinder or sparkplug by feeling for the coldest one.

The trouble shooter's tools, then, are essentially three in number: Records and reports of performance, instrument readings, and his own sensory perceptions. The value of these three factors will vary with individual cases, so a fourth item must be constantly present—the factor of good judgment.

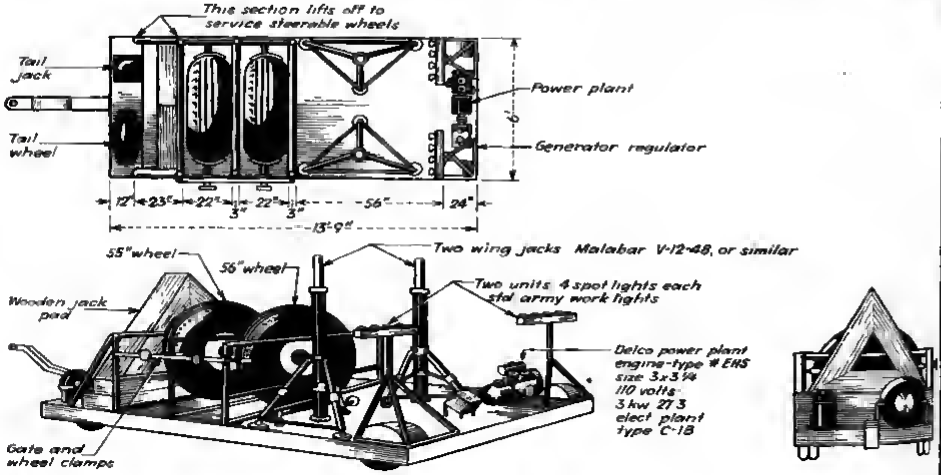
Jig Holds Air Scoop Securely

• TWA employs this carburetor air scoop jig which features a turntable base and rotary axis, enabling work to be held firmly instead of involving "wrestling" on bench. Edward Maxfield, master mechanic at Kansas City base, is shown demonstrating his invention.



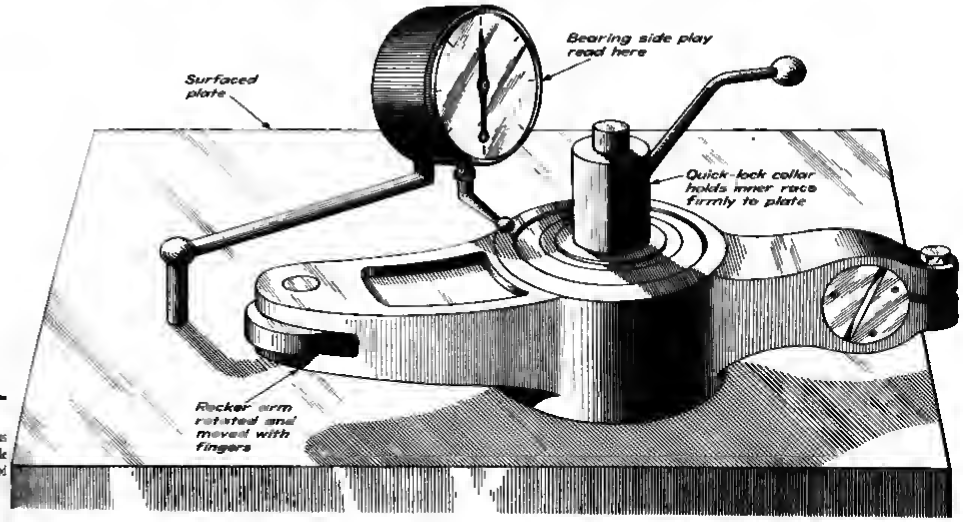
Mobile Tire-Change Unit is Convenient Time Saver

• This compact trailer, mounted on old tail wheels, carries everything required for changing tires on large bombers without towing plane a long distance down runway to hangar. Tire rack are welded of 3-in. steel pipe, while balance of construction is of wood beams and planking, metal sheathed.



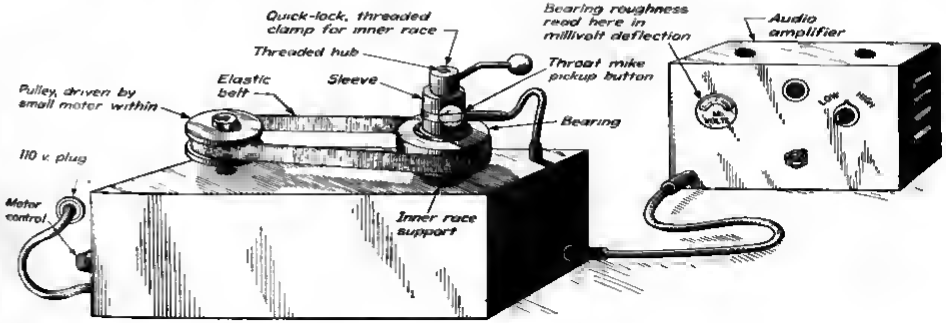
Here is Simple Fixture To Show Rocker-Bearing Play

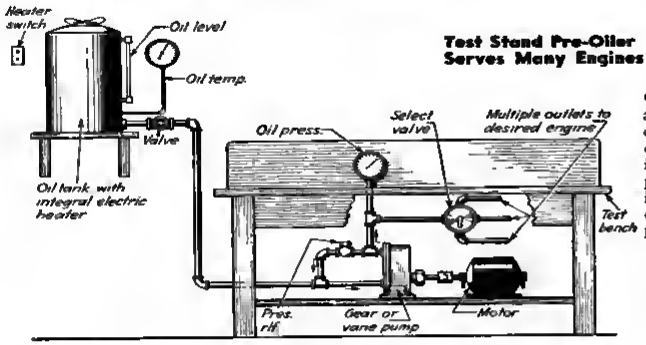
• By using a standard indicator, graduated to .001, this fixture enables mechanic to check rapidly, but with great accuracy, any side play which may have developed in rocker arm bearings.



How Throat Mike Makes Rough Bearings "Talk"

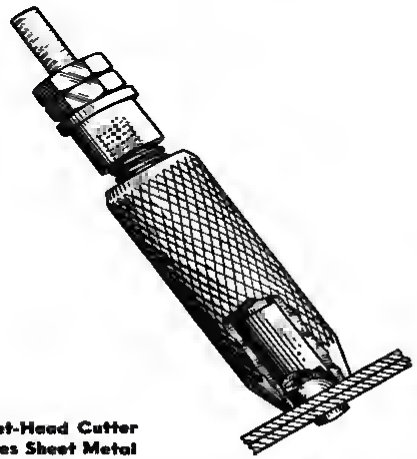
• By taping a throat mike to ball bearing shaft, roughness of bearings is reproduced as sound and millivoltmeter permits comparison between bearings, thus enabling mechanic to select those with smoothest action





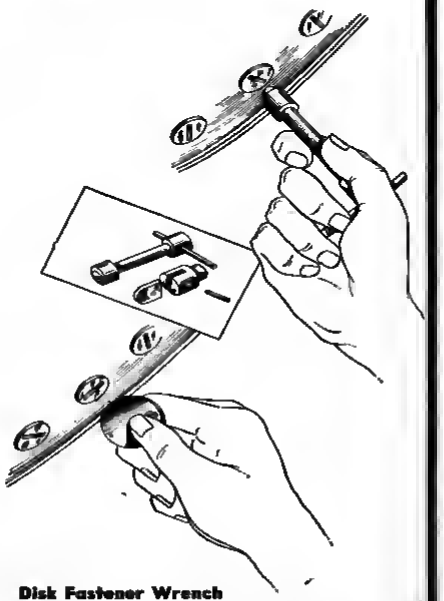
Test Stand Pre-Oiler Serves Many Engines

● Built convenient to test installation and with piping to engines, this pre- oiler may be used with a series of test cells. Always ready for use, device is available until engine builds up oil pressure, or it may be used for flushing before shutdown. Gages allow accurate regulation of temperature and pressure.



Rivet-Head Cutter Saves Sheet Metal

● A Navy civilian employe at Moffett Field, Calif., devised this tool, for use with electric drill, to cut down heads of rivets for removal without damaging surface of sheet metal. Since hole is not touched, as would be case if drilling were resorted to, plates are left in perfect condition for reworking. While cutter removes rivet head, it is prevented from marking plate by collar and spring at end next to electric drill. Knurled hand grip enables operator to locate and hold tool with least amount of fatigue. Inventor received a reward under Naval Civilian Employees Suggestion Program.

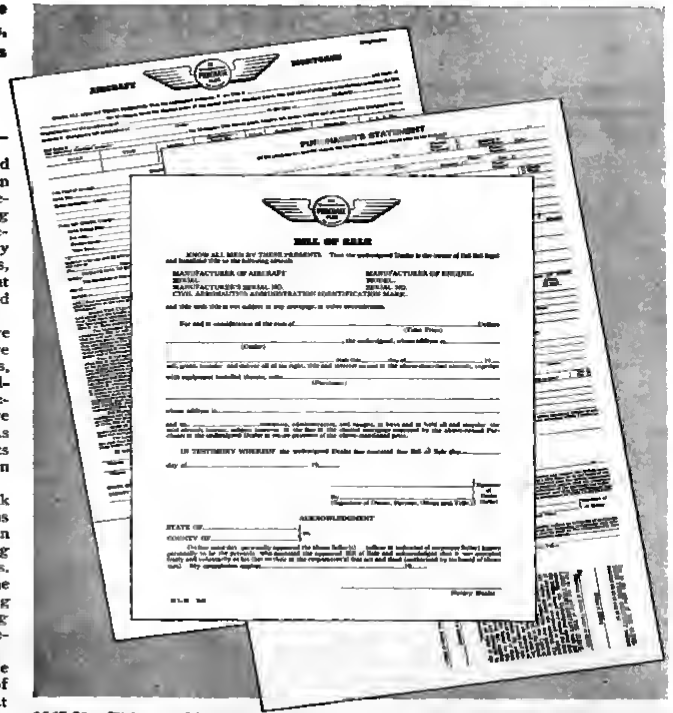


Disk Fastener Wrench

● Gilmore Peers, of Northrop final assembly, made this tool to replace old disk fastener, which had several disadvantages. New tool has a flat surface which fits on top of fastener, preventing slippage, which scarred heads. Handle provides a convenient grip enabling faster and more accurate work than with old disk-type, which cramped workers' fingers.

Offer New Finance Plan For Planes, Parts, and Repairs

Available for both fixed base operators and personal flyers, scheme backed by banks affords time-payment purchases over 12-18 month period.



BOTH fixed based operators and personal flyers interested in financing the purchase and repair of planes and equipment being made available by SWPC are now receiving encouragement to do so by some of the country's leading banks, which have worked out time-payment plans covering both aircraft sales and repairs over a 12-18 month period.

Examples of such financing have been previously set by the automotive and household appliance industries, which have built up large sales volumes—thereby reducing unit manufacturing costs — through constructive time-sales programs. Their success has influenced opinion among these banks that the same business principles can be applied to the aviation consumer.

The Cleveland Trust Co. and Bank of America are among the institutions with a time-payment plan already in operation which they are now offering to others interested in its possibilities. Included is a detailed plan of the necessary organization set-up, along with full information on financing steps, also data on joint ownership between two or three people.

These finance plans are virtually the same as for automobiles. One third of the total purchase price is required at the time of arranging the loan, and the finance charge is the same as that prevailing for cars—$6 per $100 of the original balance per annum.

For example, if an airplane plus extras and sales tax costs $1,500, the financing would be as follows:

For insurance, 13½ percent, or $202.50, would be added. This rate is possible because there is a 33⅓ percent deductable clause in case of crashes. Therefore the total basic payment would be $1,702.50, and the one-third down payment required would be $567.50. This would leave a net unpaid balance of $1,135. At the current rate, the finance charge would be $68.10, making the total unpaid balance $1,203.10. The note would be repayable in twelve monthly installments of $100.26.

The paper is without recourse, which every dealer will appreciate. Only two papers have to be signed to complete the transaction—a bill of sale and an aircraft mortgage. They both require the following information: Make and model of the airplane and serial number, make and model of engine and serial number, and the CAA identification number.

After approval by the CAA, which may take a few days, the mortgage is filed with both the CAA and local authorities, according to state law. The flying hours of owner or airplane are not considered in the financing.

Altogether, it is a very simple procedure seen as bearing much promise for everyone concerned in the manufacture and merchandising of personal planes for the postwar market.

PIPER DESIGNS NEW SKYSEDAN AND SKYCYCLE

Innovations in construction and sales-wise features mark two- and four-place craft projected by Cub-maker for postwar personal-plane market.

A FOUR-PLACER called the Skysedan, planned to sell for $2,995, and a single-seater named the Skycycle, at $900–$1,000, are among several new type personal aircraft being developed for the postwar market by Piper Aircraft at Lock Haven, Pa. The company is emphasizing that these are experimental projects and that present working plans call for production of the popular J-3 Cub Trainer and J-5C Super Cruiser as soon as the WPB makes materials available.

Both the new Skysedan and Skycycle are low-wing cantilever cabin monoplanes. The Skysedan, powered by a 165-hp. Franklin engine, will be of all-metal construction. Called for is a manually operated retractable landing gear, including tail wheel.

Specified for the fuselage is a metal-covered tubular steel frame extending to the cabin, aft of which construction would follow stressed-skin monocoque practice. The forward position of the cabin over the wing's leading edge, together with a generous amount of transparency, indicates thought given to visibility.

Tapered wings, of metal structure and fabric covering and having split edge flaps, are to house the two 20-gal. fuel tanks. A modified U.S.A. 35B airfoil is planned. Tail surfaces are to be cantilever and all metal including covering.

Performance specified includes a top speed of 140 mph., cruising speed of 125 mph., and a landing speed of 50 mph., using flaps. At fully loaded gross weight the Skysedan's range is gaged at 500 mi., plus a half-hour reserve.

An entirely different design is the single-seater Skycycle, to be powered by a 40-hp. Continental engine, with a top speed of 115 mph., cruising speed of over 90 mph., and a 350–400-mi. range. Landing gear would be fixed, with cantilever single legs attached to the front spar.

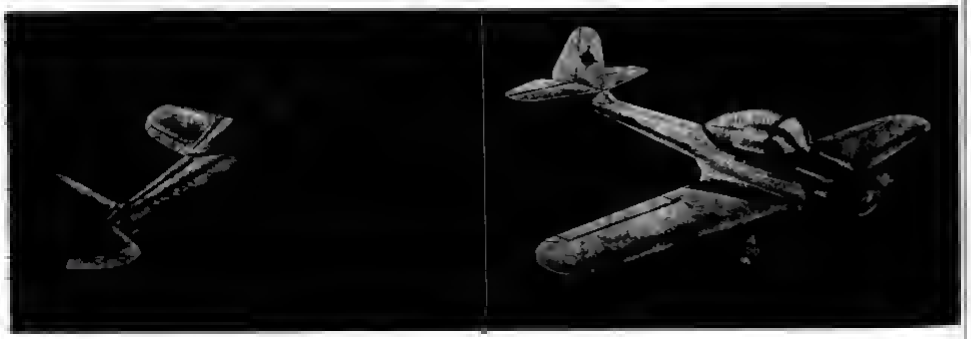
Fuselage of plastic and aluminum monocoque construction, tapering sharply aft of the cabin with tail-boom effect, is called for. A single-piece molded-plastic bubble-type cockpit canopy is planned for round-the-clock vision. The full cantilever tail unit would be of welded steel tubing, fabric covered. Wing construction would be the same as the Skysedans', using an identical airfoil section but without inclusion of landing flaps.

Prices given for these airplanes are based on estimates of volume production.

Specifications and Performance Data

	Skysedan	Skycycle
Span	34.6 ft	20 ft.
Length	20 ft.	15 ft. 6 in.
Height	7 ft.	5 ft.
Tread	12 ft.	5 ft. 11 in.
Gross weight	2,300 lb	approx. 630 lb.
Empty weight	1,250 lb	approx. 398 lb.
Fuel capacity	40 gal	10 gal.
Range	over 500 mi.	350-400 mi.
Top speed	140 mph.	115 mph.
Cruising speed	125 mph.	90 mph plus
Landing speed	50 mph	(not given)
Power	165-hp. Franklin	40-hp. Continental
Price (F.A.F.)	$2,995.	$900-$1,000

Left: Skysedan is a sleek military-looking four-place family model with flaps and retractable landing gear. Engine specified is Franklin 165-hp. Standard equipment would include electric starter and generator. Right: Single-place Skycycle is designed for 115 mph. top speed with 40-hp. Continental. Construction would be of plastic and aluminum, with weight empty about 398 lb. Featured in design are tail-boom type landgear and bubble canopy



Aeronca Presents Chum 2-Placer

Company says new side-by-side two-control light plane will be spinproof and combine proven safety features with utility and interior comfort.

A NEW TWO-PLACE PERSONAL-TYPE PLANE to be known as the Chum is the latest addition to Aeronca's growing line of postwar planes for the private flyer. It is now in the mockup stage, but the prototype is expected to be flying at an early date.

Powered by a 75-hp. engine, the Chum will have an all-metal fuselage, tricycle landing gear, and it will incorporate a spinproof two-control system under license from Engineering & Research Corp. Top speed is estimated at 120 mph., cruising speed 108, and landing speed 50 mph. Rate of climb will be 650 fpm., and cruising range 470 mi.

Features Described

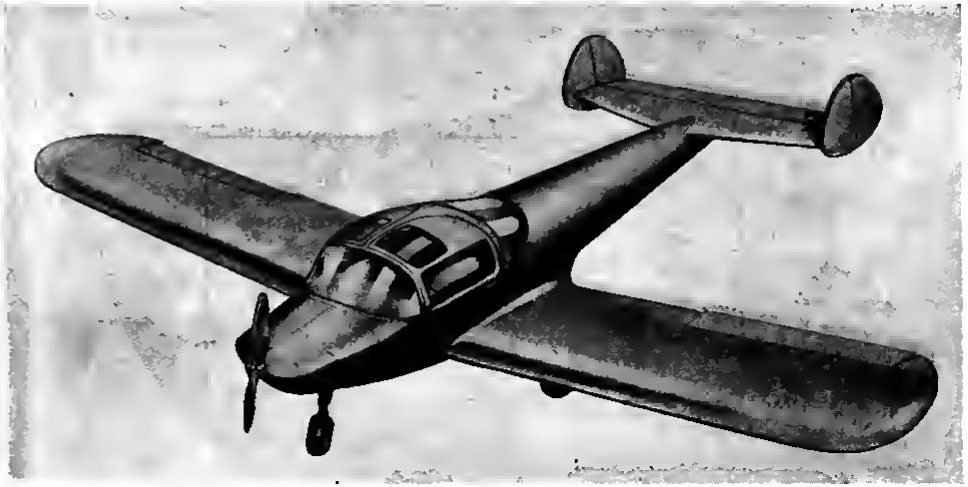
Aeronca states that large automobile type doors will permit easy access to the cabin, and that other special features will include enlarged baggage compartment, hydraulic brakes, ball bearing controls, and a de luxe interior with an instrument panel designed for eye-appeal as well as practicability. The interior is to feature roommess, a new foot rest, and an easy-action control wheel. A starter and generator will be standard equipment.

Among the other types which Aeronca is readying for the postwar market are the two-place side-by-side Chief, the tandem Champion, and the Eagle, a four-place family-type low-wing monoplane with retractable landing gear.

Specifications and Data:

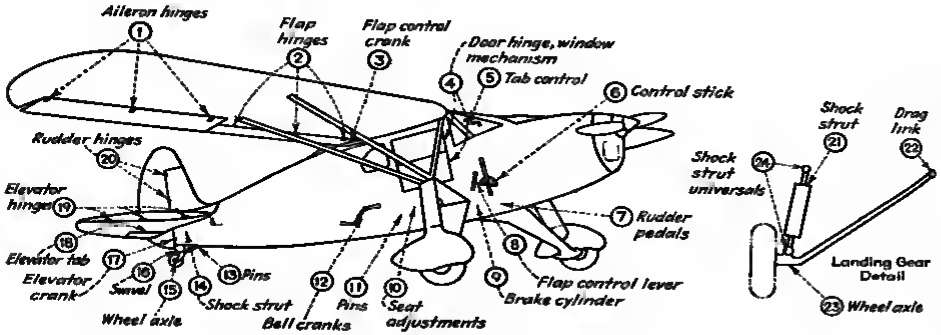
Wingspan	29 ft.
Wing area	140 sq. ft.
Wing loading	9.3 lb./sq. ft.
Gross wt.	1,300 lb.
Empty wt.	710 lb.
Useful load	590 lb.
Fuel capacity	23 gal.
Cruising range	470 mi.
Top speed	120 mph.
Cruising speed	100 mph.
Landing speed	50 mph.
Rate of climb	650 ft./min.
Baggage capacity	70 lb.
Powerplant	75-hp. engine
Passengers	two side-by-side

Artist's sketch of postwar Aeronca Chum which company states should be flying soon. A 2-place metal monoplane, powered with a 75-hp. engine, it will have tricycle landing gear. Featured are hydraulic brakes, ball bearing controls, and starter and generator as standard equipment.



AVIATION'S LUBRICATION CHART FOR FAIRCHILD

Model: 24



Engine. Uses SAE 40 (AN-VV-0-446A, grade 1080) in summer and SAE 30 (AN-VV-0-446A, grade 1066) in winter.

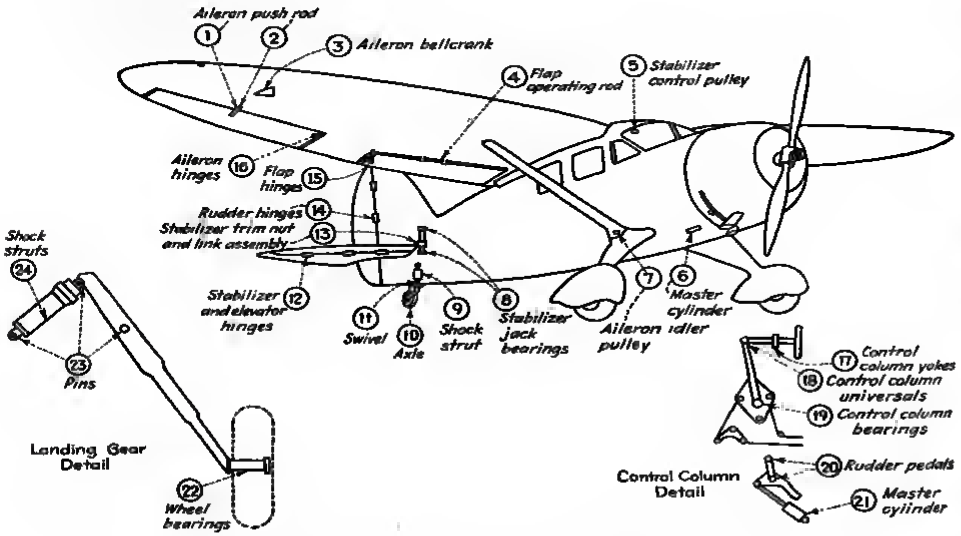
Above grades of oil are used at (1), (2), (18), (19), (20), and (24) *every 50 hr.* and at all pulleys and at (3), (4), (5), (6), (7), (8), (10), (12), and (17) *every 100 hr.*

High-low temperature grease is used at (13) and (16) *every 50 hr.*, and at (11), (15), (22), and (23) *every 100 hr.*

Hydraulic fluid (AC-3580, mineral base; or AN-3586, castor base) is used at (9), (14), and (21) *every 50 hr.*

AVIATION'S LUBRICATION CHART FOR STINSON

Model: Reliant



Engine. Uses SAE 40 (AN-VV-0-446A, grade 1080) in summer and SAE 30 (AN-VV-0-446A, grade 1065) in winter.

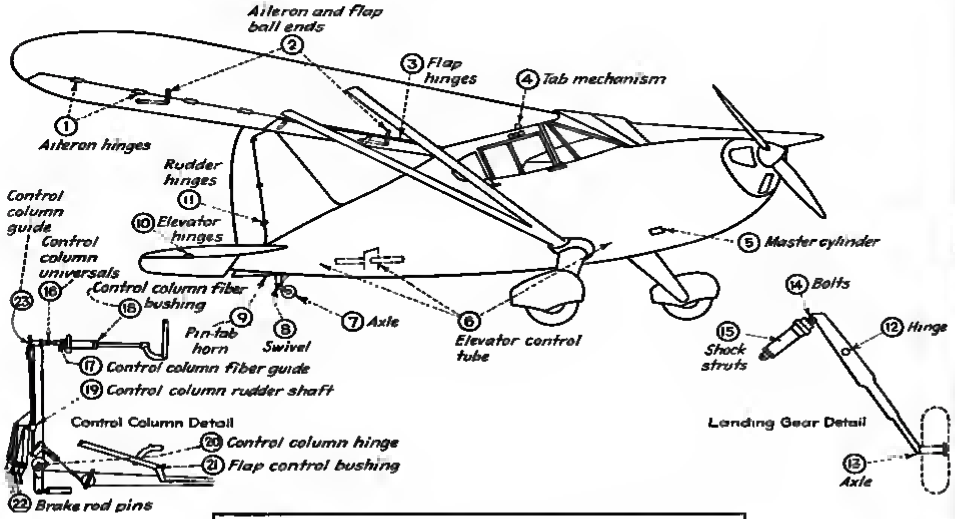
Above grades of oil are used at (8) and (13) *every 25 hr.*, at (12), (14), (15), and (16) *every 50 hr.*, at (1), (2), (7), (17), (18), (19), and (20) *every 100 hr.*, and at all pulleys and bellcranks *every 50 hr.*

High-low temperature grease (AN-G-3A) is applied *every 100 hr.* at (3), (4), (5), (10), (11), (22), and (23).

Hydraulic fluid (AC-3580, mineral base; or AC-3586, castor base) is used *every 100 hr.* at (6), (9), and (21).

AVIATION'S LUBRICATION CHART FOR STINSON

Model: 105



Engine. Uses SAE 40 (AN-VV-0-446A, grade 1080) in summer and SAE 30 (AN-VV-0-446A, grade 1065) in winter.

Above grades of oil are used *every 50 hr.* at (1), (2), (3), (4), (10), (11), (14), (16), (19), (21), and (22), also for all ball bearings, pulleys, and bell cranks.

Low temperature light instrument oil is used *every 50 hr.* at (9) and (20).

High-low temperature grease (AN-G-3A) is applied at (7) and (8) *every 25 hr.*, at (6), (12), (17), (18), and (23) *every 50 hr.*, and at (13) *every 100 hr.*

Hydraulic fluid (AC-3580, mineral base; or AC-3586, castor base) is used *every 50 hr.* at (15) and *every 100 hr.* at (5).

7 TON PAYLOAD FOR THE COMMANDO

The regular day's work for the Curtiss Commando, this giant load of supplies, will be flown from India over the hump to China by the Air Transport Command. Of the "flying freight car's" 48,000 pounds gross weight, tires consume only a small part, but they must be able to carry the load and to set it down safely on air strips of every description.

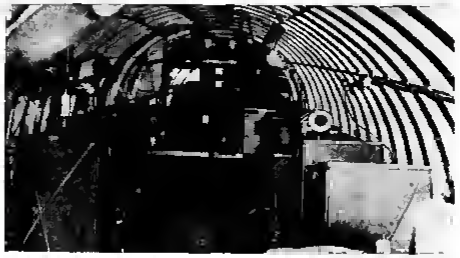
Working for the Troop Carrier Command and the Navy and Marine Corps, too, Commandos are doing duty around the globe. They are hanging up new records of fast, dependable delivery of air cargo of every type from white mice to airplane engines. The invaluable lessons learned in transport of materiel of war have led to countless improvements which make the Commando thoroughly serviceable . . . tested and proved in war for tomorrow's peace.

NO LANDINGS HERE! Hundreds of miles of terrain like this is the regular diet of the Commando pilots who fly the route from India over the hump of the Himalayas to Kunming. Commando dependability counts double over territory like this.

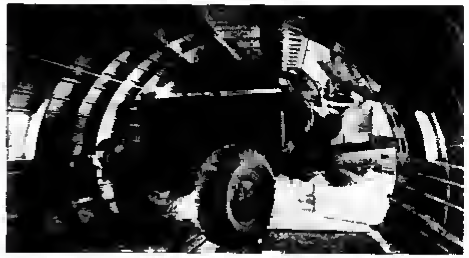
THEY CALL THEM FLYING FREIGHT CARS ... AND HERE IS WHAT THEY DO ...

SPEED SPECIAL MISSIONS . . . Twenty-two men and all their equipment packed into a Curtiss Commando C-46 fly through high altitudes over the Himalayas from India to South China.

PICK UP WOUNDED . . . Specially equipped Commandos act as hospital ships, pick up the wounded, 20 men to a plane, and evacuate them to hospitals. These planes operate regular, daily service.



FIRST AID FOR BOMBERS . . . This Curtiss Commando is a fully equipped flying machine shop ready to go to the rescue of a super-bomber forced down by mechanical trouble or battle damage.



FLY TRUCKS OVER THE HUMP . . . For trucks to carry airplanes does not seem so unusual, but here is an airplane that carries fully equipped trucks over the mountains. This time it's a weapons carrier.

RUSH THE RATIONS . . . Nothing is more important than carrying the food to Allied troops at distant outposts. This shipment of field rations being delivered by Commando is a heavy load for tires.

DELIVER SPARE ENGINES . . . Just another of the many jobs done by the "workhorse" of the Air Transport Command's global routes is delivering spare engines and engine parts to bombers in distress.

1230 SIXTH AVENUE **UNITED STATES RUBBER COMPANY** ROCKEFELLER CENTER • NEW YORK 20, N.Y.

TOMORROW'S AVIGATION FACES NEW FACTORS

By M. D. LOWENSTEIN, *Lieutenant USNR*

(Opinions herein do not necessarily reflect views of Navy Department.)

With the future's boost in speed and range, inherent terrestrial forces considered pertinent to meteorological data, but not to flight, will be factors of vital influence in avigation. Here's a basic explanation of these forces and how they affect the aerial picture.

HIGH-ALTITUDE and jet-propelled planes and V-type rockets—in addition to their importance in relation to specialized fields of structural engineering, combustion, electronics, and meteorology—are advents in the general field of avigation. But despite great advances made in the study of external ballistics, the precision attained in high altitude bombings has not been achieved with "vengeance" rockets.

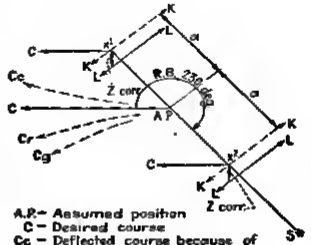
Further usefulness, especially for commercial purposes, of these modern aircraft is dependent upon more complete control of flight. Among the most important relevant factors which require accurate evaluation, are the external forces of nature.

So long as avigation is concerned with moderate speeds and distances over the conventional routes, only simple direct readings from a few instruments suffice for accurate results. But when the speeds begin to approach the speed of the earth's rotation—as when great circle routes become circumpolar—the previously acceptable results become scarcely more than approximations, and corrections of errors introduced by the effects of the earth's velocity considerably modify the solutions obtained by orthodox avigational procedure.

Among important effects, account of which has to be taken, are those introduced by the size, shape, and other characteristics of the earth and its atmosphere. It is to be expected that the tremendous mass of earth-atmosphere, spinning at about 900 mph. at the equator, influences the mass of a plane or rocket as its velocity approaches that of the earth.

The earth is a gigantic gyroscope, and any changes in distribution of its mass — even the relatively small changes occasioned by the flight of a plane or rocket—affects many forces. But the modification of gravity-effects, centrifugal force, and precession cannot, because of the immensity of the earth, influence its course. Hence the plane or rocket is affected, and the familiar obvious computations for wind, altitude of celestial bodies, etc., require correction.

Several of the corrections are accounted for in the *American Air Almanac*; however, the practical form in which the succinct information is presented, does not reveal much of the source or theory from which the corrections were derived. An elaboration of this material known as Z-correction for bubble sextant*, is given here, together with a more thorough discussion of the external effects on masses moving over the earth's surface.



A.P.– Assumed position
C – Desired course
Cc – Deflected course because of Coriolis alone
Cg – Deflected course because of gyro wander alone
Cr – Resultant course because of Coriolis and gyro wander
Z – Correction
S – Celestial body
K-K'– Line of position, uncorrected
L-L'– L.O.P., corrected for Z
x^1 – L.O.P., away
x^2 – L.O.P., toward
a – Intercept
R.B.– Relative bearing

Fig. 1. Diagrammatic representation of Z-correction

Z - Correction for Bubble Sextant

Example. Given: T.A.S., 270 mph (235 kt.); lat. N. 56 deg.; wander to starboard of gyro equals 0.75 deg./min.; and relative bearing 230 deg. (port) of celestial body.

Find: Correction to be applied to a Sumner line.

Solution: From Table (1) in *American Air Almanac* the values are + 5 min. (because of Coriolis—a deflective acceleration) and —9 min. (because of gyro precession) = —4 min. (combined value).

From Table (11), the Z-correction is seen to be 3 min., which is to be added to the value of the observed altitude.

Any mass moving on the surface of the earth (including the atmosphere) is affected by deflection accelerations. These accelerations are the result of the mass moving from one latitude to another, and of the rotation of the earth. The resultant latitude and Coriolis effects cause an error in bubble sextant readings which must be corrected. The effects may be combined with another source of error—gyro wander—and tabulated. The resultant correction is known as the Z-correction for bubble sextants, and is independent of the course of the mass relative to the earth.

In the northern hemisphere, the latitude and Coriolis deflective accelerations have a direction to starboard of the course of a moving body, and are accompanied by a force in the direction of the acceleration. The curvature of the course, therefore, is to port. In the southern hemisphere the reverse effects are observed.

Using the example given in *Amer-*

* From *American Air Almanac*, 1944

can Air Almanac, in Fig. 1 let C be the desired course, and Cc the course made good because of latitude and Coriolis effects only. A sight is taken on a body whose relative bearing is 230 deg. As the body is to port, and the course made good is to starboard of the desired course, the correction will have to be subtracted from the observed altitude in ordec to have the correct relationship between the celestial body and the plane's position. If this were the only correction the 5 min. found in the latitude column of Table (1) would be subtracted from the observed altitude.

The problem states that there is a gyro wander to starboard. The gyro lies with its axis horizontal. The wander records an increasing reading of the instrument as the aft end moves to starboard. To maintain a given course, a force must be applied to port, which, while recording a constant reading of the instrument, produces a course made good to port of the course desired. The curvature of this course is therefore to starboard, and is shown as Cg.

The sight taken on the celestial body to port will be incorrect if it is assumed to be made while the plane is on C, the course desired. The course made good, Cg, is nearer the celestial body and the correction 9 min. must be added to the altitude to have the correct relation between the celestial body and the plane's position.

The difference between the desired course and each of the courses made good, Cc and Cg, are combined into a single correction for L.O.P., which varies in amount with the plane's speed and is obtained from Table (1), and applied to the Sumner line. The example in *American Air Almanac* has a resultant course, Cr, to port and closer to the body, and the correction is therefore added. Whether the plane's position, in this problem, is x^1 or x^2 (a—away, or a—toward) the correction to be applied to the intercept is added.

If the correction is to be applied to the body's altitude, rathec than to L.O.P., the combined values found in Table (1) are modified according to the relative position of the body, and Z rrom Table (11) is then used.

Whethec applied to L.O P. or to altitude, the combined correction from latitude, Coriolis, and gyro wandec is a function of the plane's speed. The fastec it moves along the track away from A.P. the greater the diffecenec between the course desired and the course made good.

Earth Effects on Surface Masses

Masses on or near the surface of the earth, which have no motion relative

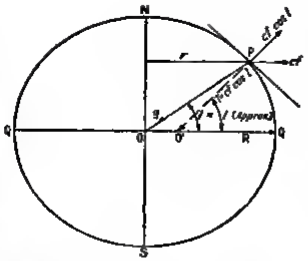


Fig. 2. Representation of gravity and centrifugal force.

to the earth, are acted upon by two earth forces—gravity and centrifugal force.

The force of gravity, g, among other effects, tends to pull all masses approximately toward the center of the earth (Fig. 2). Centrifugal force, *cf*, tends to throw all masses in a direction away from the axis of the earth, and at right angles to it. The resultant of gravity and centrifugal force, T, acts at right angles to the oblate-shaped surface of the earth and there is no effective component toward the equator, because the earth is progressively flattened toward the poles. The resultant which holds the mass to the earth, therefore, does not pass exactly through the earth's center, O, but passes through some point O^1.

Since the force T is greater than is necessary to hold the mass on the earth, thece is a residual gravitational force called weight, $W = mg$, and it varies with latitude. That is, as centrifugal force varies with the radius, r of the circle through which the mass rotates, the value of T varies and the weight will also vary. The weight of any given mass which is stationary relative to the earth, decreases as its position approaches the equator. Near the poles, the circle of rotation is least, and the centrifugal force being

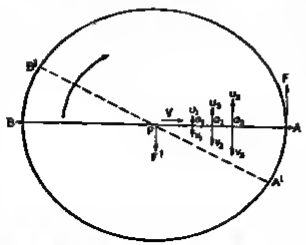


Fig. 3. Diagram of forces affecting earth and space directions.

small, the weight of a mass increases as its position approaches that of the poles.

The variation in weight of a mass stationary relative to the earth, may be illustrated by the following example: Let centrifugal force, $cf = mrw^2$, in which w is the angular velocity of the earth's rotation and r the distance of m from the earth's axis.

The mean radius of the earth, R, equals 6,371 km. (polar radius = 6,357 km, equatorial radius = 6 378 km). Since $r = R \cos l$, and $cf = mR \cos l\ w^2$, then at 40 deg. lat. the decrease in weight W according to these equations, is $\frac{W}{494}$.*

A slight variation in weight also occurs with altitude, in accordance with $g = g^0/(1 + Z/E)^2$, where g is the varying gravity acceleration, g^0 is gravity acceleration at a given latitude, E is mean radius of earth, and Z is altitude in meters.

If a mass has a velority relative to the earth, the centrifugal force changes, and with it, the weight of the mass. In the formula for centrifugal force $cf = mV^2/r = mrw^2$, w^2 is decreased by one part in eight at a latitude of 40 deg. and a velocity from west to east of 80 km./hr. That is, under these conditions, a mass weighs less than an equal mass moving from east to west by about 1 part in 1,976.

Rotation

Further effects of relative velocity on a mass have to do with the course of the mass as it moves on a rotating body, e.g. the earth. These effects vary with the distance from the axis of rotation (latitude) and the velocity of the mass, and are divided for convenience of study, into: (1) Latitude effect, and (2) Coriolis effect.

The former is the deflective effect of the N-S component of the course and is at its maximum when the mass is on a N-S or S-N heading. The latter is the deflective effect on the E-W component of the course and is at its maximum when the mass is on a E-W or W-E heading. It is the effect under these maximum conditions which will be considered. Both latitude and Coriolis effects are in the same direction within the same hemisphere, and by simply adding them together the combined effect is obtained.

Latitude Effect

Imagine looking up at the earth from space from a point south of the south pole so that the latter seems like the stationary center of a flat revolving plate. The atmosphere, as part of the spinning earth, is an extension of this turning disk. A meridian such as P A (fig. 3) moves around P with a certain angular velority, w.

Masses, with no velority relative to the earth, and stationed, respectively, on the meridian at a_1, a_2, and a_3, each have, due to the earth's angular velority, different linear (tangential) velorities in the direction shown: v_1, v_2, and v_3. Therefore, if a mass, m, crosses from P to A with a uniform velority, V (the earth rotating, as shown, with an angular velocity w), the mass is subject to the different velorities of points a_1, a_2, and a_3.

Any mass that is subject to a variation in velority, increased or decreased, is said to acquire acceleration (or deceleration). Acceleration, in accordance with Newton's law, can only be accomplished by a force acting in the direction of acceleration. In the case of the rotating earth, let the force exerted on the mass equal f. The direction of the force is shown by the velocity v_1, v_2, and v_3. It is at right angles to the velocity of the mass toward A and therefore leaves V unaffectrd.

The amount of the force F, necessary to balance f and to keep the mass on a course toward A, is the latitude effect. It causes a deflection to the left of the meridian PA. The movement of the mass from P toward A simulates movement from 90 deg. south lat. to 0 deg. lat.

The same effect of moving to the left of the course is observed when a body travels in the reciprocal direction—as though it moved from the periphery of a revolving disk, toward the center. If a plane is at point A and takes the reciprocal heading of PA, as determined by the celestial body, this heading is first APB. But when the plane reaches P's position, B on the earth has travelled to B^1, while the space direction B remains unchanged.

During the time the plane is travelling, the earth tries to impart to the body moving toward P, the decreased tangential linear velocities (or deceleration) successively at the points a_3, a_2, and a_1. The plane arrives at point a_2 with a tangential velority equal to the earth's greater tangential velocity at a_3. The earth's velority tends to retard or to pull the plane to the right of its course at a_2 in the direction u_2 with force f.

To keep its original space heading to B, the plane exerts a force in the opposite direction—to the left of its course. To continue in this original space direction, the plane resists deflection with a force F¹ against the "braking action" of the slower earth velocities at greater latitudes. These act at right angles to the course of the body and therefore as before do not affect its velority relative to the earth.

If a plane's velocity is great, that is, if the plane traverses P to A or A to P in a short period of time, t, then changes from v_1 to v_2 etc. are rapid. Since v_1, v_2, and v_3 are each constant and if t be sufficiently small, the maximum value of the acceleration, a, may be determined. From the value of a, f may be determined in the fundamental equation $f = ma$, m being constant.

In order that the mass reach A on the earth from P, or reach P from A, F must equal f. It can then be shown that $F = 2\ mwV$.

It is seen that a change in linear velority at right angles to the course of the mass orcurs when it moves from the center of a rotating disk toward the periphery (Fig 3)—from the pole to the equator; or from the periphery toward the center—from the equator to the poles. This change in velocity (acceleration or deceleration) defines a force f. As previously stated, to balance this force and maintain the mass in its space direction, another force, F, opposite in direction to f is required.

In the southern hemisphere as m moves north or south, it is carried to the left of the S-N or N-S course (meridian PA). For the northero hemnsphere, it can be similarly shown that a mass moving south from the north pole, is deflected to the right of its N-S course, such as NB in Fig. 4. Also, in the northern hemisphere a mass moving north is deflected to the right of its S-N course, such as PC.

Another explanation for latitude effect is derived from the law of angular momentum. If the radius of rotation, r, of a mass rotating around the axis of the earth with a velority V, be decreased by having the mass move north or south, the work done on the mass is $-F\,dr$, indicating the decreasing value of r and a force F opposing centrifugal force.

The work performed on a body is equal to the gain in kinetic energy—$E = 1/2mV^2$. From $dE = -F\,dr$, the relationship $mVr = Cmwr^2$ is derived. The expression mVr is known as the angular momentum of the body and the equation expresses the principle of conservation of angular momentum. It signifies that as the distance from the center of rotation to the particle becomes smaller, the particle must increase its linear and angular velority. A displacement of a mass poleward brings it closer to the axis of rotation and results in an increase of angular velocity.

An apparent acceleration to the east is produced, which is an acceleration to the right of the course in the northern hemisphere, and to the left in the southern hemisphere.

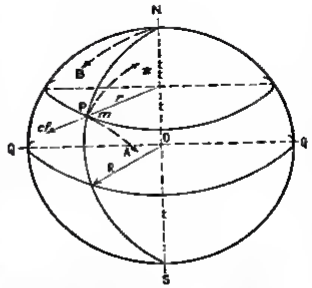


Fig. 4. Effects of earth's deflective accelerations on a mass.

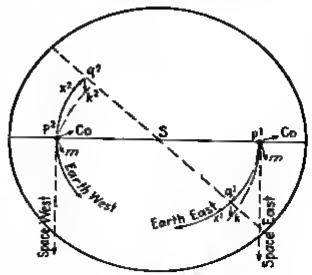


Fig 5. Diagram of Coriolis effect on a mass located in southern hemisphere.

Coriolis Effect

Assume that m is not at a pole or the equator, or moving north or south, but is at some latitude south of the equator, as position P^1 (Fig. 5). If m is at rest in refecenre to the earth at P^1, all forces acting on it are in equilibrium. Components of centrifugal force, gravity, and friction are all balanced, and m's linear (tangential) velority is easterly. If, however, an attempt is made to give m additional easterly tangential velority in the direction of the earth's rotation, the balance is disturbed.

Mass m will then move with a greater linear velocity than that provided by the earth's tangential velority at P^1. As previously stated, a difference in velority is an acceleration (or deceleration) and indicates the existence of a force. The direction of this force at any time is easterly and corresponds

(*Turn to page 249*)

* A general equation for variation of weight with latitude, stated in c.g.s. units, is $g = 980 \times (1 - 0.00264 \cos 2\ l)$, where l is latitude and g the varying gravity acceleration.

HIGH VS[illegible]ANSPORT

PART III

By PHILIP COLMAN, *Chief Aerodynamics Engineer, Lockheed Aircraft Corp.*

Detailing design and performance characteristics of cruising superchargers, the author concludes his series with premises for added economy at high altitudes through use of turbine driven and heat exchanger for both carburetor and cabin heater.

TO FLY at 25,000 ft., it is necessary to supercharge the intake air from atmospheric pressure up to that required by the engine to develop its power. Two methods which are used today are: First, the geared supercharger driven by the engine; second, the turbo supercharger, which derives power from the exhaust gases.

Before an evaluation of the two methods can be made, the effect of exhaust back pressure on the engine, or the brake specific fuel consumption, should be understood. This effect is a function of valve and spark timing as well as of pumping characteristics, and each particular engine design must be studied to determine its magnitude. Experimental data is also needed for verification. However, assuming the engine is tested with this end in mind, the increment should be obtainable. To explain the reasons for deduction from bmep, three effects on engine operation must be listed.

At a constant manifold pressure, the power varies with altitude due to the following factors:

(1) An increase of altitude reduces atmospheric temperature, due to the standard altitude variation. Lower temperature means higher relative density, so that a greater mass of air is taken into the cylinder. Thus a higher power is obtained, but only because of increased volumetric efficiency. The power increases with the mass of air and fuel, which means an increase of power, but with no change in specific fuel consumption. The effect on bhp. is approximately 1 percent increase for each 10 deg. F. decrease in temperature, but no change in fuel per bhp.-hr.

(2) A decrease in back pressure results in improved scavenging of the cylinder. Exhausting a larger portion of the burned gases allows the intake of a larger volume of charge. The power increase is due to increased volumetric efficiency, but specific fuel consumption is unchanged. The effect is an increase of 0.5 percent in power for each inch of mercury reduction in back pressure, but with the same fuel consumption per bhp.-hr.

(3) Change of back pressure may also have an added effect at cruising power. The pressure against which the piston pumps on its exhaust stroke is directly reduced as the port pressure is reduced. The increment in power reduction may be shown by the equation:

$$\text{bhp} = \frac{\Delta P\,(A)\,(N)}{2\,(12)\,(33{,}000)}$$

where: P = back pressure reduction increment in psi.
A = engine displacement in cu. in.
N = engine rpm,

Since this expression is identical to one for bmep, the increment in back pressure may be written as an increment in bmep.:

$$\Delta P = \frac{792{,}000\ (\text{bhp.})}{A\,N}$$

Thus is added engine power for a given manifold pressure and fuel charge, and it will show as a reduction in sperific fuel cousumption. Thus,

$$\frac{(SFC)_2}{(SFC)_1} = \frac{bmep._1}{bmep._1 + \Delta P}$$

For example, if an engine obtains minimum specific fuel consumption (SFC) at approximately 140 bmep a change of 2 psi. in back pressure will result in a reduction in fuel consumption of:

$$\Delta SFC = -\frac{140}{142} = 1.5 \text{ percent}$$

To compare the two metheds of supercharging, assume we nred a sea level carburetor pressure at 25,000 ft. First consider the geared blower, which experience has shown must be two-stage, delivering air to the carburetor. The equation for power required by the blower is:

$$P_r = \frac{P_1\,(Q)}{\eta\,(33{,}000)}\left[\frac{\lambda}{\lambda - 1}\right]\left[\left(\frac{P_2}{P_1}\right)^{.286} - 1\right]$$

where; P_1 = 25,000 ft. pressure in psf.
Q = quantity of carburetor flow in cu.ft./min.
= compressor efficiency, assumed here to be 50 percent
P_2 = sea level pressure in psf.

For example, for 2,000 bhp. with an airflow of 7,000 cu.ft. min:

$$P_r = \frac{785\ (7\,000)}{.50\ (33{,}000)}\left[\frac{1.4}{.4}\right]\left[\left(\frac{2{,}120}{785}\right)^{.286} - 1\right]$$

= 382 hp., or 19.1 percent of the bhp. delivered to the propeller.

Above engine might be equipped with short exhaust pipes, designed to obtain an exhaust jet effect. Calculations show that a jet pipe, designed for operation at all engine powers, is capable of delivering up to 9 percent of the engine bhp. at cruising speed at 25,000 ft. In addition, exhaust back pressure will be approximately 1 psi. above atmospheric pressure, or 6.5 psi. Saving compared to sea level fuel consumption (based on 140 bmep.) will be:

$$\Delta SFC = 1 - \frac{140}{148.2} = 5.6 \text{ percent}$$

Thus the specific fuel consumption of the integrally supercharged engine at 25,000 ft. may ideally be:

$SFC.$ = 19.1 — 9.0 — 5.6 = 4.5 percent above that at sea level.

A similar calculation may be approximated for power plant equipped with a turbosupercharger. The supercharger costs nothing in power to operate, deriving its energy from the exhaust gases. Calculations at 25,000 ft. and cruising power have shown that the turbine can be driven with a back pressure of 8.5 psi. The reduction in specific fuel consumption compared to sea level:

$$\Delta SFC = 1 - \frac{140}{146.2} = 4.5 \text{ percent}$$

With proper turbo design, the exhaust outlet may be formed to a jet to recover some of the energy. Approximately 1 percent bhp. may be recovered at cruising speed.

Thus a net reduction of fuel consumption of approximately 5.5 percent may be effected with turbosupercharging as compared to 4.5 percent for an integrally supercharged design. This 10 percent difference in terms of fuel and oil required for a 4,000 mi. range, (Fig. 2, p. 171 Jan. AVIATION) is 10 percent of the 19.8 percent basically required, or 1.98 percent of the airplane gross weight. For the 200,000 lb. plane, this represents 3,960 lb. payload.

Points which have not been mentioned in this theoretical discussion concern practical installation problems. A long-range high-altitude transport must be equipped with three items closely allied to the power plant. One is the cabin supercharger, which requires approximately 1.5 percent of engine power for geared supercharger and 1.5 percent additional engine fuel per hour. Cabin pressure may also be obtained from the turbosupercharger, increasing the engine back pressure only slightly, and raising fuel consumption less than 0.5 percent.

Second consideration is means to supply heat for maintaining cabin temperature and for ice prevention for the wing and tail surfaces. If the above is accomplished by exhaust heat exchangers the jet thrust advantage of the integrally supercharged installation will be materially reduced. If separate fuel burners are used for heating, the gasoline required must be added.

Third item, carburetor heating means, also involves collecting some of the exhaust gases, reducing the effectiveness of the exhaust thrust.

Summing up, advantages are with the turbosupercharged installation—for minimum fuel required and for maximum payload in a long-range high-altitude transport. As will be explained, the turbine must be specially designed for the transport airplane.

A common mistake is the rating of turbosuperchargers in terms of the engine power that they will accommodate. It is true that at a given altitude, there is a maximum engine power that each turbine can maintain; but, at another altitude, this power is changed due to variation of air density.

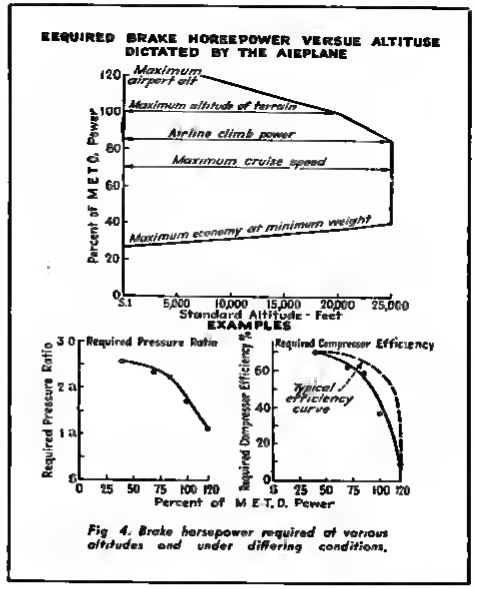


Fig. 4. Brake horsepower required at various altitudes and under differing conditions.

It is intended to present here the concept of the *cruising turbosupercharger*, so named because it is sized to extend cruising power of an engine to high altitudes, while maintaining the carburetor pressure required for full engine power only to moderate altitudes and with reduced efficiency. The cruising turbine is deliberately made too small to boost takeoff power up to 25,000 ft., since for a transport airplane this rating would be of no use; but it is sized to boost cruising power to 25,000 ft., because this power range is the important one.

Power-Altitude Chart

Fig. 4 presents the power chart required of the long-range high-altitude turbosupercharged transport. The chart of power versus altitude is derived from consideration of what may be obtained. The following points are assumed:

(1) Takeoff power, 120 percent of m.e.t.o. power, is required by the CAR previously discussed. Taking off from an airport at any altitude, gross weight of the airplane must be reduced until the airplane can climb to 50 ft. from the ground with one engine inoperative before reaching the end of the runway. Thus maximum takeoff power is desired at the highest airport altitude, because any required reduction in geoss weight would mean a reduction in payload. Of regularly scheduled airports in the U.S., the highest are at Santa Fe, N.M. (6,675 ft.); Rawlins, Wyo. (6,780 ft.), and Flagstaff, Ariz. (6,587 ft.). In neighboring countries, Mexico City airport is at 7,342 ft. Therefore, the altitude for 120 percent m.e.t.o. power recommended on the chart is 7,000 ft.

(2) For normal rated power (100 percent m.e.t.o. power) the only importance to transport operation is its use for climb and ceiling in cruising with one engine inoperative. Civil Aeronautics Regulations require that an airplane exhibit a prescribed rate of climb at an altitude 1,000 ft. higher than any point en route. In the U. S. a ceiling of 15,000 ft. is sufficient, but in some neighboring countries 20,000 ft. will be required. Maintaining 100 percent m.e.t.o. power to 20,000 ft. will insure ample performance

(3) Climb to cruising altitude is made at between 70 and 85 percent m e t o power. Choice of best climbing power depends on the route flown as well as the rate of climb and fuel consumption. Therefore, 85 percent m e t o power should be maintained to cruising altitude, 25,000 ft.

(4) Maximum cruising power (maximum power that engine may operate at with lean mixture) is approximately 70 percent m e t o. Minimum cruising power is that required for most economical speed when airplane is at minimum flying weight, that is, near the end of a long flight when most of the fuel has been used. This power is 40 percent m e t o for the airplane in question, at 25 000 ft.

(5) To complete the chart, powers for maximum economy flight at minimum weight at other altitudes are found. This power varies as the square root of density ratio, and thus is 27 percent m.e.t.o. at sea level.

Power chart Fig. 4 represents the writer's definition of the term, "c r u i s i n g turbosupercharger". The turbine should be designed to boost engine hp from 40 to 85 percent m e t o power up to cruising altitude, and it should have sufficient capacity at reduced efficiency to sustain higher hp at the altitudes shown. To transpose this into what is required in turbo compressor performance, the other charts in Fig. 4 have been derived. The lower left-hand chart shows pressure ratios required, based on a boosting power of a typical low altitude engine. It must be noted that the application of the turbosupercharger does not eliminate entirely the geared supercharger, which must be used to insure good fuel vaporization.

Thus the carburetor pressure required for each power varies according to the operation of the integral blower, which is changed by the airflow and engine rpm. To obtain the required carburetor pressures for the powers in the chart, the pressure ratios shown in Fig. 4 are determined. The maximum pressure ratio of 2.6 is necessary at the minimum power, 1.1 for takeoff power.

To put this in terms of compressor characteristics, the compressor efficiency or pressure coefficient is calculated and plotted in the lower right-hand chart of Fig. 4. Necessarily an approximation, this is obtained by assuming that the maximum speed of the turbine is necessary for all points, depending on the efficiency curve. The efficiency is:

$$\eta P = \frac{6,088\ T\ Y}{(V_T)^2}$$

where: T = absolute temperature

$$Y = \left(\frac{P_2}{P_1}\right)^{.286} - 1$$

V_T = tip speed, assumed to be constant for all points.

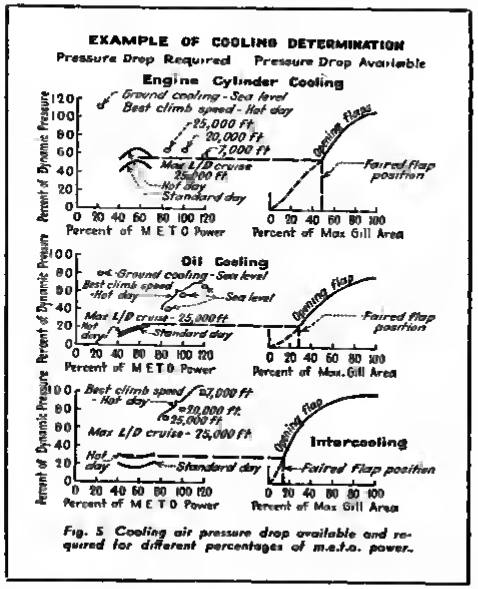


Fig. 5 Cooling air pressure drop available and required for different percentages of m.e.t.o. power.

Points of the power chart are entered into the efficiency chart of Fig. 4. For the tip speed chosen (1,040 ft./sec.) a maximum efficiency of 70 percent is required at 40 percent m.e.t.o. power, an efficiency of percent is required for takeoff power. A curve faired through the points shows a much steeper efficiency change than is the normal compressor characteristic. This, demonstrated by the two curves in the chart, shows that the turbine rpm. for the right four points would be considerably reduced.

The 40 percent power point on the left of the efficiency curve of Fig. 4 would approximate the minimum flight power available at best economy engine rpm. at 25,000 ft. This is dictated by the pulsation point of the compressor, below which a surge will occur and the turbine cannot operate. The variation of surge limit below 25,000 ft. may be traced to complete the check of the power chart. The surge limit occurs at a certain ratio of carburetor airflow to turbine rpm. Assuming a constant sperific air consumption, the surge-limit power will vary directly with the turbine speed. Thus as the atmospheric pressure increases with decrease in altitude, the pressure ratio required through the compressor will decrease.

A check shows that with a minimum power at 40 percent m e t o at 25 000 ft. the surge-limit power will be 22 percent at 15,000 ft., 5 percent at 5,000 ft. These points are below the airplane power for maximum economy on the power chart, Fig. 4, and therefore do not affect the requirements.

This analysis has shown that the requirements for a cruising turbosupercharger are possible from the compressor standpoint, assuming that the spread in the efficiency curve can be obtained. This spread may be slightly greater than is available with current turbine design, but it is believed that a unit designed sperifically for this purpose could obtain the characteristics shown in Fig. 4.

Nothing has been said about the exhaust turbine requirements. Turbine design is quite flexible and can be made to obtain any desired results. However it has been demonstrated that back pressure intimately affects engine fuel consumption and thus payload. The lower the back pressure in the cruising range, the better the economy. This will be found to be consistent with high power requirements, because it dictates large areas for exhaust nozzles.

Back pressure at takeoff will of necessity be relatively high. Effect of back pressure on engine operation has always been a question, because little experimentation has been done along this line. If bhp. is maintained by increasing manifold pressure with back pressure, there is a range of moderately high back pressure where engine operation should be satisfactory, by evidence from the engine manufacturers. The turbine design can accommodate limitations if they are known.

Cruising Turbosupercharger Design Specifications

The previous section has dealt solely with performance requirements. If the design of the nacelle must be compromised to accommodate the turbine, advantages may be lost in net airplane drag and weight. In other words, for the long-range transport airplane, this unit must be a new design, arranged to fit the nacelle rather than having the nacelle designed to fit the turbine. The importance of weight and drag factors may be demonstrated by the following calculations:

For a large 4-engine airplane, nacelle drag is approximately 20 percent of the total parasite drag, when of good aerodynamic design. To illustrate the affect of greater nacelle size, an example of the effects of 12 in. increase in dia. is given. On an original dia. of 65 in., 12 in. more dia. means an increase in frontal area of 40 percent. Nacelle drag would be increased 40 percent. Airplane parasite drag is half total drag at maximum economy speed. Thus the maximum L/D would be decreased 4 percent, fuel increased 4 percent. For our example airplane, 19.8 percent of the gross weight was fuel—39,600 lb. gasoline—and 12 in. of added nacelle dia. will require another 1,590 lb of fuel plus oil, equal to 4 percent of the payload or 9 passengers.

Weight of an existing turbosupercharger is considerable. Designed for cruising it should be possible to make the weight less than that of the second stage of a two-stage integral supercharger. To illustrate the effect, calculation of the cost of 1,000 lb is made. Breguet's formula gives:

$$\text{Range} = 375\left(\frac{\eta}{C}\right)\left(\frac{L}{D}\right)\log\left[\frac{\text{initial wt.}}{\text{final wt.}}\right]$$

Assuming constant propeller efficiency η, sperific fuel consumption C and L/D are unaffected by weight. For a given range the ratio of initial to final weight is constant. In our example, 19.8 percent gross weight was required for fuel plus oil, or the ratio of initial to final weight was 100/80.2 = 1.25. Thus, if empty weight is increased 1,000 lb., final weight will be increased 1,250 lb, the added 250 lb. being fuel to carry the added empty weight plus added fuel weight. The longer the range, the higher this fuel factor becomes. For 4,000 mi., takeoff weight must be increased 1,250 lb., or 5 passengers must be left off.

Weight and drag effects demonstrate that the cruising turbine must be designed to realize the advantages offered. Performance must be achieved within the dimensions of a low altitude nacelle.

One other factor should be noted in conjunction with this. A high altitude transport will require cabin supercharging for which approximately 1.5 percent of cruising bhp. is required. If driven from the engine crankshaft, another 1.5 percent more fuel is required and 1.5 percent less payload can be carried. The cruising turbosupercharger described will pressurize the cabin under all flight conditions for a small increase in back pressure, affecting fuel consumption less than 0.5 percent, another 1 percent advantage.

In the design of a cruising turbosupercharger, disposition of the inlets and outlets is important. The axis of wheel rotation should be parallel to the engine thrust. The compressor air intake should face forward to obtain the maximum ram pressure from the scoop. Since the carburetor is often on the top side of the engine, and intercoolers are required to cool the compressed air, the compressor discharge opening should be on the top of the turbin, discharging at a right angle to the wheel axis. The turbine can most conveniently obtain the exhaust flow if the inlet is directed forward, so that a direct connection can be made.

The turbine exhaust should be directed aft, first, because advantage should be taken of the exhaust flow to obtain a thrust effect (about 1 percent of engine power, but it more than makes up for the drag entailed in the carburetor air scoop); second, because of the requirement for a large heat exchanger to provide hot air for anti-icing and cabin heating. This exchanger will have a sizable pressure drop, increasing the back pressure, whereas a straight duct will minimize this back pressure, which is of utmost importance.

A control waste gate must be incorporated in the system, and for the sake of a minimum size and weight heat exchanger, and maximum jet thrust, the by-passed exhaust should return to the system behind the turbine. These are design problems which cannot be attained by compromising with an existing turbine, but must be incorporated in a new design for a specific application.

For general considerations of design, the following points should be noted:

(1) Reliability is paramount and must be consistent with requirements of a long-range transport.

(2) Maintenance shall be similar to that of the engine and shall require no more frequent service.

(3) Turbine must be designed for operation at the high exhaust temperatures coincident with maximum economy carburetor settings.

Miscellaneous Power Plant Components

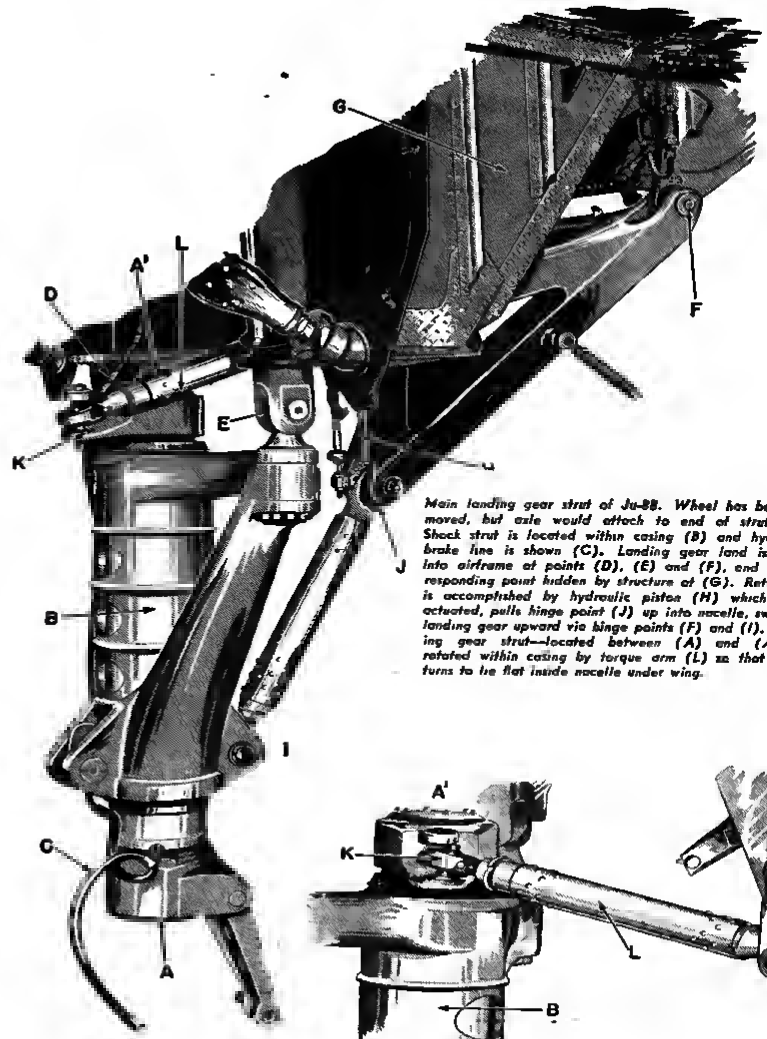
For their operation, the engine and turbo must be cooled. The power chart Fig. 4 illustrates what condition of flight is critical for each cooling element. Fig. 5 gives typical engine heat dissipation data, along with the theoretical heat variation.

Engine cylinder cooling is represented by the top chart. Pressure drop required on the left chart shows the relative importance of various conditions. It will be seen that because cruising power is maintained to a higher than normal altitude (along with the low allowable head temperatures and the low indicated airspeed for heat range), cruising powers require as great a pressure drop as climb powers. Thus a faired flap gill area chosen for a standard day will suffice for cruising or climb flight, and cowl flaps need only be opened for an extremely hot day or for ground cooling conditions.

Center chart of Fig. 5 shows relative importance of various flight conditions on oil cooling. For this, the greater the power, the larger the pressure drop required. Flaps may be designed to fair for cruise flight, and open for high-power climb on a hot day.

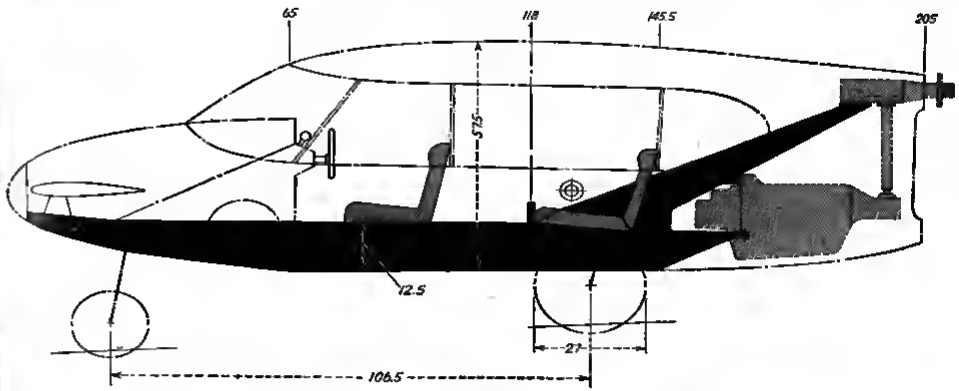
Bottom chart of Fig. 5 shows intercooling requirements, based on a cruising turbine and engine combination following the points of the power chart. For cruise conditions, the turbine is operating in its high efficiency range, and the temperature rise due to the desired pressure ratio is a minimum. For higher powers, where the turbine is working less efficiently and is at lower altitudes where atmospheric temperature is higher, intercooling is more important. Selecting the faired flap position for hot-day cruise requires flap opening for climb. Limiting carburetor temperatures for these conditions must be obtained from the engine manufacturers. These maximum allowable temperatures are for the hot-day climb condition with takeoff and m e t o power, and they must be carefully calculated so that the intercooler size will not be excessive.

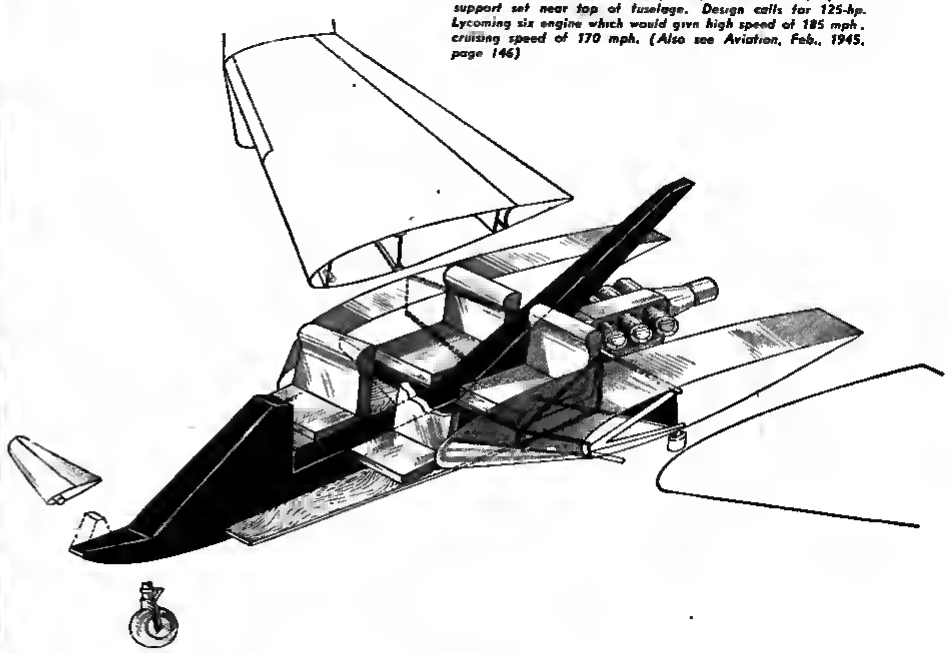
For heating the airplane, an exhaust heat exchanger is desirable. In the design, minimum efficiency of this unit was at lowest flight power, which occurred at maximum power of the light airplane at sea level. This controlled Btu output of the exchanger. However, the takeoff power condition gave the maximum exchanger pressure drop with corresponding output.



Main landing gear strut of Ju-88. Wheel has been removed, but axle would attach to end of strut (A). Shock strut is located within casing (B) and hydraulic brake line is shown (C). Landing gear load is taken into airframe at points (D), (E) and (F), and a corresponding point hidden by structure at (G). Retraction is accomplished by hydraulic piston (H) which when actuated, pulls hinge point (J) up into nacelle, swinging landing gear upward via hinge points (F) and (I). Landing gear strut—located between (A) and (A')—is rotated within casing by torque arm (L) so that wheel turns to lie flat inside nacelle under wing.

Close-up of wheel rotation mechanism shown in large sketch, with torque arm (L) and hinge point (K) shown in position at beginning of retracting motion.





Profile (top) and cutaway views of Naugle N-6, design for postwar canard type personal plane. Heart of plane is stainless steel "keel" in center of craft, extending aft from nosewheel support through fuselage to engine mount and propeller support set near top of fuselage. Design calls for 125-hp. Lycoming six engine which would give high speed of 185 mph., cruising speed of 170 mph. (Also see Aviation, Feb., 1945, page 146)

Cutaway view of new Stinson Voyager 125, showing construction of welded chrome-moly steel tubular fuselage, stamped metal ribs and spruce spars. Powered by 125-hp. Lycoming six, craft has high speed of 123 mph., cruising speed of 112 and landing speed of 51 mph. Gross wt. is 1,875 lb., wt. empty, 1,118 lb

AVIATION'S *New Regular Feature*

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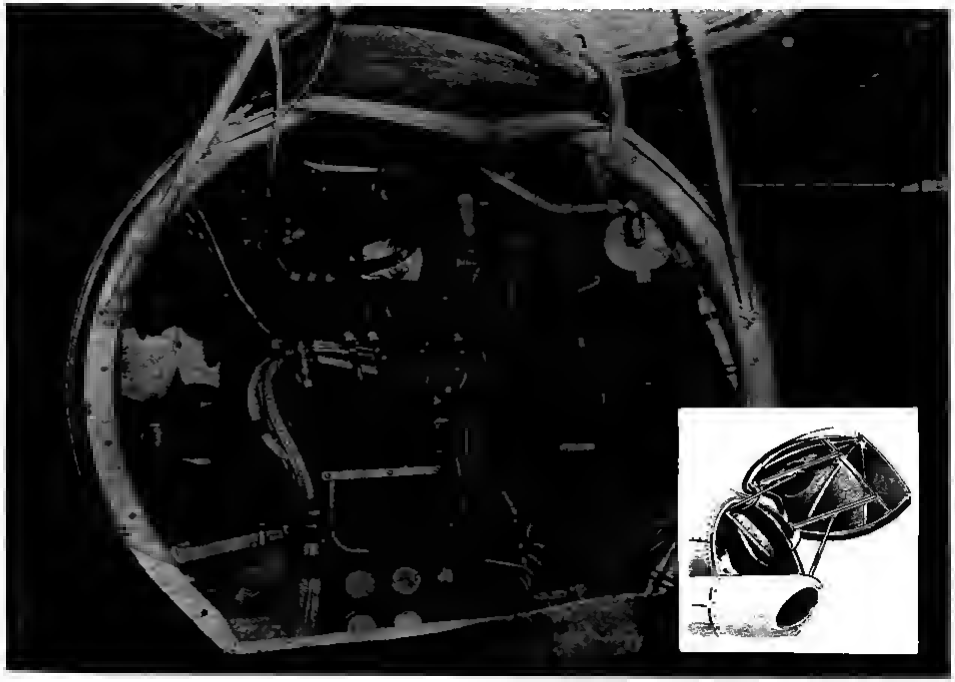
UTILIZATION KEYNOTES CHANGE OF C-46 INTO CW-20E

NOTEWORTHY FUNCTIONAL improvements have been achieved in various modifications entailed in the redesign of Curtiss-Wright's C-46 Commando to the new commercial transport counterpart—the CW-20E.

The nose cone—formerly attached by a series of screws—now utilizes a door section hinged at the top for quick opening to provide ready inspection and servicing of units forward of the instrument panel. Quick fasteners are located at each side of the nose at the lower portion of the cone door, and a hand-operated latch is in the cabin air-intake

Another door in the lower right side of the fuselage nose section under pilot's compartment allows easy access to various controls and equipment.

Accessibility to rear of instrument panel and other units on Curtiss-Wright's CW-20E is simplified by use of quick-opening nose-cone door hinged at top. Inset shows view of nose with door in open position.



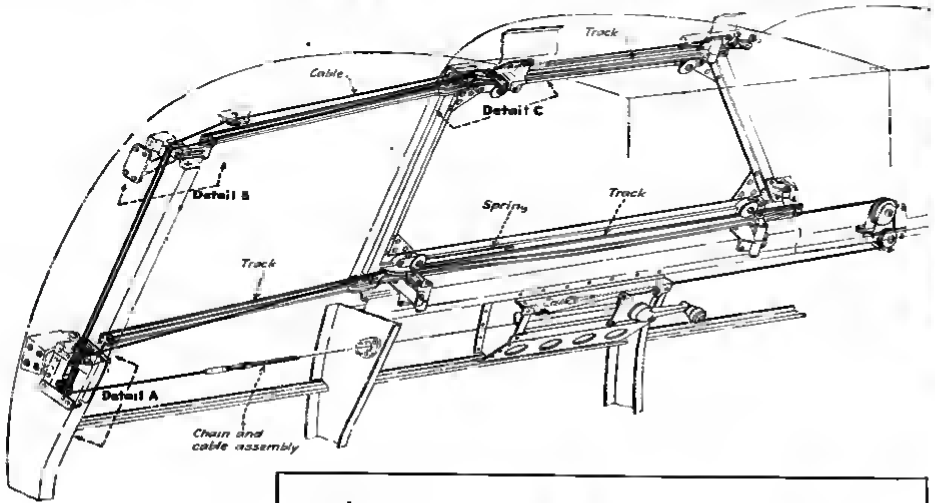
This cockpit view of CW-20E shows V-shaped improved-visibility flat windshield consisting of double panels of laminated plate glass with space between for circulation of heated air. In flight position, 18 in. eye-distance from panel gives angle of vision of 16 deg. up and 15½ deg. down. Oblique panels at each end of front windshield open in to provide unobstructed vision in very heavy rain. Side panels (one is seen at left) are hand-cranked for opening to rear and move outward at end of closing travel for tight seal. Interchangeable duplicate flight instrument sub-panels serve pilot and co-pilot.

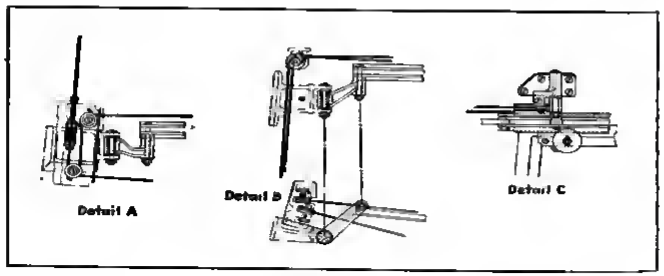
Improved visibility with reduction in refractive and reflective errors is a feature of the new windshield design. Included is a V-shaped forward windshield, an oblique window at each end, and another window placed longitudinally at each side. All panels are flat laminated plate glass.

Front windshield, made of double panels with space between to permit thermal de-icing, has approximate dimensions of 21.5 x 12.5 x .422 (inner) x .374 (outer). Outer panel consists of a forward layer of .109 chipping-resistant semi-tempered glass, an aft layer of .250 full-tempered glass, with .015 vinyl plastic between. Inner panel has .1875 and .1094 semi-tempered glass forward and aft, respectively, with .125 vinyl plastic between, and it opens inwardly for cleaning without interfering with controls.

The installation is considered practically birdproof, since information in-

Perspective view showing installation details of sliding side window in cockpit of CW-20E.





dicates that the greatest protection against heavy birds is afforded by a thick vinyl. The glass shatters but the thick vinyl acts as a net, preventing a bird from entering the cockpit even though it comes through the heavy forward piece of glass

Both panels of the windshield are so constructed as to be removable as a unit with the frame. The forward panel, installed with a soft rubber gasket to eliminate distortion, can be sealed in its frame and tested before installation

The oblique panel at each end of the front windshield is approximately 7.125 x 12.25 x 308, consists of .109 semi-tempered glass forward and aft, and .090 vinyl plastic, and is hinged on inboard side to open inward to afford unobstructed vision in very heavy rain.

Side windows are approximately 17.5 x 17.5 x .308, with .109 semi-tempered glass fore and aft, and .090 vinyl plastic between. They are crank-operated for sliding open to the rear, and at end of closing travel move outward to provide effective sealing

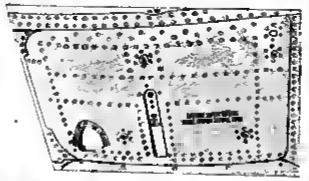
Distance from normal position of pilot's eyes to front windshield has been reduced from over 30 in. to 18 in., thus increasing visibility by increasing the angle between upper and lower limits of vision, and in flight position, the average pilot has an angle of vision of 16 deg. up and 15½ deg. down, measured from horizontal line at eye level. By leaning forward, angle of vision is further increased. This was not accomplished with the old windshield, since, when leaning forward, the angle changed very little because of the greater distance from the windshield.

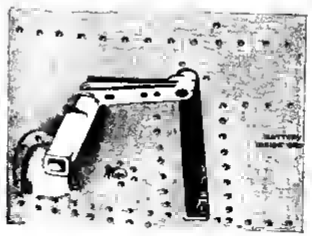
Rearrangement of the instrument panel affords pilot and co-pilot duplicate flight instrument sub-panels which are interchangeable to facilitate maintenance. All units on the instrument panel, except auto-pilot shut-off valve and light receptacles, are front-mounted and with flexible hose connections permit rapid removal and installation.

The radio installation has been redesigned, this equipment being located on the centerline and right side of plane from aft of co-pilot's seat to cabin partition. All junction boxes are consolidated into one unit located on the side of main radio rack. Wiring is routed along the right side of the overhead panel under a snap-on insulation strip for easy access. All control units are contained in a consolidated panel located just above the center of the windshield, accessible for operation by pilot and co-pilot, and fitted with slide fasteners to facilitate maintenance. A quickly removable hinge permits complete removal of entire panel for replacement

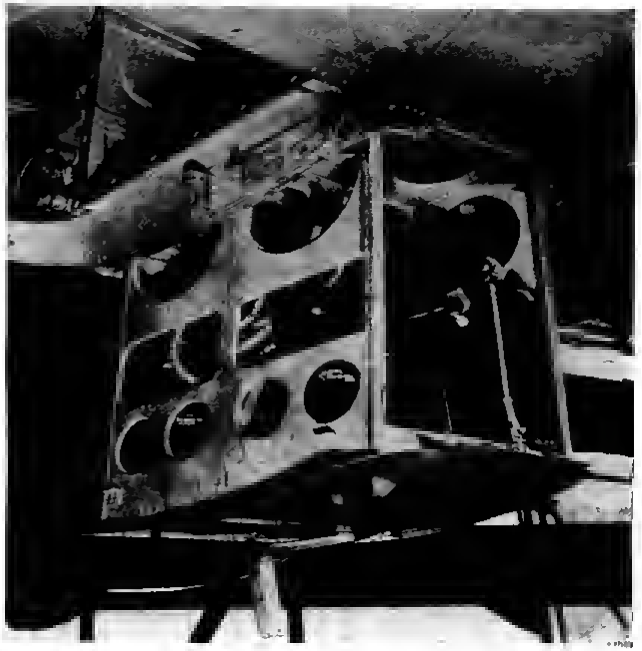
Batteries have been relocated in the fuselage lower surface just forward of the ground service access door and are mounted on an elevator type carriage raised and lowered by a jackscrew and handcrank mechanism, and which moves vertically when the plane is in three-point position. In level flight position, the carriage travels up and ahead, and a spring-loaded cable assembly attached to the upper portion compensates for possible binding as a result of bending moment created by the angularity. A safety latch is provided to lock carriage in the up position.

A simple mechanical linkage connecting each landing gear door to the main strut has been installed to replace the hydraulically operated door mechanism and thus sequence valves and associated hydraulic plumbing are eliminated.





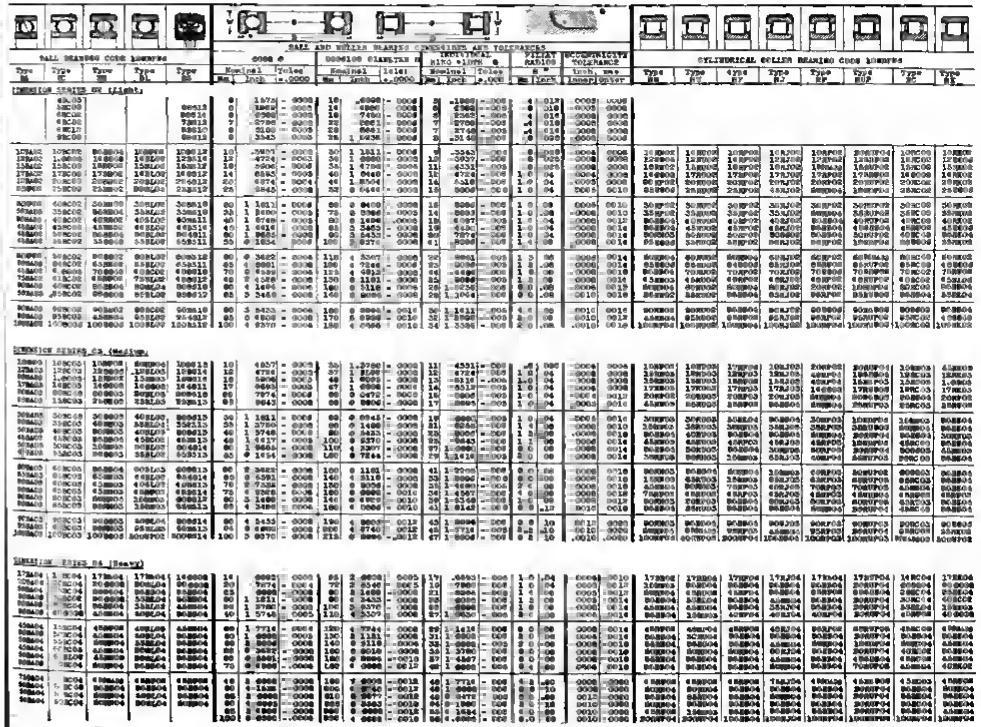
Right: Practical elevator carriage used on CW 20E facilitates inspection, maintenance, and servicing of battery from ground. Safety latch (upper center) locks carriage in up position. Sketches above show carriage retracted with flush handcrank and also with latter extended for lowering operation.



SHEET NUMBER . . . . . D-26 (cont'd from Feb.)
CLASSIFICATION . . . . . Materials
SUB CLASSIFICATION . . . . . Ball & Roller Bearings

Standard Dimensions And Tolerances

For ball bearings Types BA, BC, BH, BL & BS and cylindrical roller bearings Types BN, RU, RF, RJ, RP, RUP, BC & BB



SHEET NUMBER . . . . . D-26 (cont'd)
CLASSIFICATION . . . . . Materials
SUB CLASSIFICATION . . . . . Ball & Roller Bearings

Standard Dimensions and Tolerances

For ball bearings Type BD and cylindrical roller bearings Types RU, RN, RF, RJ, RC, & RK

BALL BEARING CODE NUMBERS	BALL AND ROLLER BEARING DIMENSIONS AND TOLERANCES												CYLINDRICAL ROLLER BEARING AN00 NUMBERS					
	608S B			OUTER DIAMETER O			INDIVIDUAL RING WIDTH S			FILLET RADIUS	ECCENTRICITY TOLERANCE						
Type BD	Nominal Mm	Nominal Inch	Toler +.0000	Nominal Mm	Nominal Inch	Toler +.0000	Nominal Mm	Nominal Inch	Toler +.000	R* Mm	R* Inch	inch Inner	max Outer	Type RU	Type RN	Type RF	Type RJ	Type RC	Type RK
DIMENSION SERIES 02 (Light)																			
10BD02	10	.3937	-.0005	26	1.0236	-.0006		5/16	-.006	.5	.020	.0006	.0006	10RU02	10RN02	10RF02	10RJ02	10RC02	10RK02
12BD02	12	.4724	-.0005	32	1.2598	-.0006		3/8	-.006	.5	.020	.0006	.0006	12RU02	12RN02	12RF02	12RJ02	12RC02	12RK02
15BD02	15	.5906	-.0005	32	1.2598	-.0006	10.0	3/8	-.006	.5	.020	.0006	.0006	15RU02	15RN02	15RF02	15RJ02	15RC02	15RK02
17BD02	17	.6693	-.0005	40	1.5748	-.0006	10.0	3/8	-.006	.5	.020	.0006	.0006	17RU02	17RN02	17RF02	17RJ02	17RC02	17RK02
20BD02	20	.7874	-.0005	47	1.8504	-.0006	11.5	7/16	-.006	1.0	.040	.0006	.0006	20RU02	20RN02	20RF02	20RJ02	20RC02	20RK02
25BD02	25	.9843	-.0006	52	2.0472	-.0006	12.5	1/2	-.006	1.0	.040	.0006	.0006	25RU02	25RN02	25RF02	25RJ02	25RC02	25RK02
							14.0	9/16	-.006	1.0	.040	.0006	.0006						
							15.5	5/8	-.006	1.0	.040	.0006	.0006						
							17.5	11/16	-.006	1.0	.040	.0006	.0006						
							20.5	13/16	-.006	1.0	.040	.0006	.0006						
							23.5	15/16	-.006	1.0	.040	.0006	.0012						
30BD02	30	1.1811	-.0004	62	2.4409	-.0006	25.0	15/16	-.006	1.0	.04	.0006	.0016	30RU02	30RN02	30RF02	30RJ02	30RC02	30RK02
35BD02	35	1.3780	-.0005	72	2.8346	-.0006	27.0	1 - 1/16	-.006	1.0	.04	.0006	.0016	35RU02	35RN02	35RF02	35RJ02	35RC02	35RK02
40BD02	40	1.5748	-.0005	80	3.1496	-.0006	30.2	1 - 3/16	-.006	1.0	.04	.0006	.0016	40RU02	40RN02	[illegible]	40RJ02	40RC02	40RK02
45BD02	45	1.7717	-.0005	85	3.3465	-.0006	33.3	1 - 5/16	-.006	1.0	.04	.0006	.0016	45RU02	45RN02	45RF02	45RJ02	45RC02	45RK02
50BD02	50	1.9685	-.0005	90	3.5433	-.0006	33.3	1 - 5/16	-.006	1.0	.04	.0006	.0016	50RU02	50RN02	50RF02	50RJ02	50RC02	50RK02
55BD02	55	2.1654	-.0006	100	3.9370	-.0006	35.5	1 - 5/16	-.006	1.5	.06	.0006	.0016	55RU02	55RN02	55RF02	55RJ02	55RC02	55RK02
60BD02	60	2.3622	-.0006	110	4.3307	-.0006	38.5	1 - 7/16	-.006	1.5	.06	.0006	.0016	60RU02	60RN02	60RF02	60RJ02	60RC02	60RK02
65BD02	65	2.5591	-.0006	120	4.7244	-.0006	38.1	1 - 1/2	-.006	1.5	.06	.0006	.0016	65RU02	65RN02	65RF02	65RJ02	65RC02	65RK02
70BD02	70	2.7559	-.0006	125	4.9213	-.0006	38.1	1 - 9/16	-.006	1.5	.06	.0006	.0016	70RU02	70RN02	70RF02	70RJ02	70RC02	70RK02
75BD02	75	2.9528	-.0006	130	5.1181	-.0006	41.3	1 - 5/8	-.006	1.5	.06	.0006	.0016	75RU02	75RN02	75RF02	75RJ02	75RC02	75RK02
80BD02	80	3.1496	-.0006	140	5.5118	-.0006	44.4	1 - 3/4	-.006	2.0	.08	.0006	.0016	80RU02	80RN02	80RF02	80RJ02	80RC02	80RK02
85BD02	85	3.3465	-.0006	150	5.9055	-.0006	46.2	1-15/16	-.005	2.0	.08	.0016	.0016	85RU02	85RN02	85RF02	85RJ02	85RC02	85RK02
90BD02	90	3.5433	-.0006	160	6.2992	-.0010	52.4	2 - 1/16	-.005	2.5	.08	.0016	.0016	90RU02	90RN02	90RF02	90RJ02	90RC02	90RK02
95BD02	95	3.7402	-.0006	170	6.6929	-.0010	58.8	2 - 3/16	-.005	2.5	.08	.0016	.0016	95RU02	95RN02	95RF02	95RJ02	95RC02	95RK02
100BD02	100	3.9370	-.0006	180	7.0866	-.0010	60.3	2 - 3/8	-.006	2.5	.08	.0016	.0016	100RU02	100RN02	100RF02	100RJ02	100RC02	100RK02
DIMENSION SERIES 03 (Medium)																			
10BD03	10	.3937	-.0005	26	1.3780	-.0005	15.0	3/4	-.006	.5	.020	.0006	.0008	10RU03	10RN03	10RF03	10RJ03	10RC03	10RK03
12BD03	12	.4724	-.0003	37	1.4567	-.0005	15.0	3/4	-.006	1.0	.04	.0006	.0008	12RU03	12RN03	12RF03	12RJ03	12RC03	12RK03
15BD03	15	.5906	-.0003	42	1.6535	-.0005	15.0	3/4	-.006	1.0	.04	.0006	.0008	15RU03	15RN03	15RF03	15RJ03	15RC03	15RK03
17BD03	17	.6693	-.0004	47	1.8504	-.0005	20.2	7/8	-.005	1.0	.04	.0006	.0008	17RU03	17RN03	17RF03	17RJ03	17RC03	17RK03
20BD03	20	.7874	-.0004	52	2.0472	-.0005	22.2	7/8	-.005	1.0	.04	.0006	.0016	20RU03	20RN03	20RF03	20RJ03	20RC03	20RK03
25BD03	25	.9843	-.0004	62	2.4804	-.0006	22.2	1 - [illegible]	-.005	1.5	.04	.0006	.0016	25RU03	25RN03	25RF03	25RJ03	25RC03	25RK03
30BD03	30	1.1811	-.0004	72	2.8346	-.0005	30.2	1 - 3/16	-.005	1.5	.06	.0006	.0016	30RU03	30RN03	30RF03	30RJ03	30RC03	30RK03
35BD03	35	1.3780	-.0005	80	3.1496	-.0006	34.9	1 - 3/8	-.005	1.5	.06	.0006	.0016	35RU03	35RN03	35RF03	35RJ03	35RC03	35RK03
40BD03	40	1.5748	-.0005	90	3.5433	-.0006	38.5	1 - 7/16	-.005	1.5	.06	.0006	.0016	40RU03	40RN03	40RF03	40RJ03	40RC03	40RK03
45BD03	45	1.7717	-.0005	100	3.9370	-.0006	39.7	1 - 9/16	-.006	1.5	.06	.0006	.0016	45RU03	45RN03	45RF03	45RJ03	45RC03	45RK03
50BD03	50	1.9685	-.0005	110	4.3307	-.0006	44.4	1 - 3/4	-.006	2.0	.08	.0006	.0016	50RU03	50RN03	50RF03	50RJ03	50RC03	50RK03
55BD03	55	2.1654	-.0006	120	4.7244	-.0006	46.2	1-15/16	-.005	2.0	.08	.0006	.0016	55RU03	55RN03	55RF03	55RJ03	55RC03	55RK03
60BD03	60	2.3622	-.0006	130	5.1181	-.0006	54.0	2 - 1/8	-.005	2.5	.08	.0006	.0016	60RU03	60RN03	60RF03	60RJ03	60RC03	60RK03
65BD03	65	2.5591	-.0006	140	5.5118	-.0006	58.7	2 - 5/16	-.006	2.5	.08	.0006	.0016	65RU03	65RN03	65RF03	65RJ03	65RC03	65RK03
70BD03	70	2.7559	-.0006	150	5.9055	-.0006	63.5	2 - 1/2	-.006	2.5	.08	.0006	.0016	70RU03	70RN03	70RF03	70RJ03	70RC03	70RK03
75BD03	75	2.9528	-.0006	160	6.2992	-.0010	66.2	2-11/16	-.006	2.5	.08	.0006	.0016	75RU03	75RN03	75RF03	75RJ03	75RC03	75RK03
80BD03	80	3.1496	-.0006	170	6.6929	-.0010	68.3	2-11/16	-.006	2.5	.08	.0002	.0016	80RU03	80RN03	80RF03	80RJ03	80RC03	80RK03
85BD03	85	3.3465	-.0006	180	7.0866	-.0010	73.0	2 - 7/8	-.005	2.5	.10	.0016	.0016	85RU03	85RN03	85RF03	85RJ03	85RC03	85RK03
90BD03	90	3.5433	-.0006	190	7.4803	-.0012	73.0	2 - 7/8	-.005	2.5	.10	.0010	.0020	90RU03	90RN03	90RF03	90RJ03	90RC03	90RK03
95BD03	95	3.7402	-.0006	200	7.8740	-.0012	77.0	3 - 1/16	-.006	2.5	.10	.0010	.0020	95RU03	95RN03	95RF03	95RJ03	95RC03	95RK03
100BD03	100	3.9370	-.0006	215	8.4646	-.0012	82.6	3 - 1/4	-.006	2.5	.10	.0010	.0020	100RU03	100RN03	100RF03	100RJ03	100RC03	100RK03
DIMENSION SERIES 04 (Heavy)																			
17BD04	17	.6693	-.0005	62	2.4804	-.0006	20.2	1 - 3/16	-.005	1.0	.04	.0006	.0010						
20BD04	20	.7874	-.0004	72	2.8346	-.0006	34.9	1 - 3/8	-.006	1.0	.04	.0006	.0010						
25BD04	25	.9843	-.0004	80	3.1496	-.0006	33.3	1 - 5/8	-.006	1.5	.06	.0006	.0016						
30BD04	30	1.1811	-.0004	90	3.5433	-.0006	39.7	1 - 5/16	-.006	1.5	.06	.0006	.0014						
35BD04	35	1.3780	-.0006	100	3.9370	-.0006	44.4	1 - 3/4	-.005	1.5	.06	.0006	.0014						
40BD04	40	1.5748	-.0006	110	4.3307	-.0006	42.2	1-15/16	-.005	2.0	.08	.0006	.0014						
45BD04	45	1.7717	-.0006	120	4.7244	-.0006	54.0	2 - 1/8	-.005	2.0	.08	.0006	.0014						
50BD04	50	1.9685	-.0006	130	5.1181	-.0006	58.7	2 - 5/16	-.006	2.0	.08	.0006	.0016						
55BD04	55	2.1654	-.0006	140	5.5118	-.0006	63.5	2 - 1/2	-.006	2.0	.08	.0006	.0016						
60BD04	60	2.3622	-.0006	150	5.9055	-.0006	66.7	2-11/16	-.006	2.0	.08	.0006	.0016						
65BD04	65	2.5591	-.0006	160	6.2992	-.0010	71.4	2-15/16	-.006	2.0	.08	.0006	.0016						
70BD04	70	2.7559	-.0006	180	7.0866	-.0010	79.4	3 - 1/8	-.006	2.5	.10	.0006	.0016						
75BD04	75	2.9528	-.0006	190	7.4803	-.0012	82.5	3 - 1/4	-.005	2.5	.10	.0006	.0020						
80BD04	80	3.1496	-.0006	200	7.8740	-.0012	87.3	3 - 7/16	-.006	2.5	.10	.0006	.0020						
85BD04	85	3.3465	-.0006	210	8.2677	-.0012	88.1	3 - 5/8	-.005	3.0	.12	.0010	.0020						
90BD04	90	3.5433	-.0006	225	8.8583	-.0012	98.4	3 - 7/8	-.006	3.0	.10	.0010	.0020						

* The corner radius or chamfer on bearings must clear the maximum fillet radius given in the table. This specification does not control bearing corner contours

(Courtesy of Anti-Friction Bearing Manufacturers Assn.)

(To be continued)

The AVIATION NEWS

ELAINE STUBBLEFIELD, Washington HERB POWELL, New York

New Representative Committee Gets Big Role In Shaping of Postwar Personal Aviation

. . . Regulation seen stated for non-scheduled operations . . . Confusion won't curb drive for airfields . . . NACA drafts statement of research policy . . . ACC-PAC status seems scarce of firms in membership . . . Simpler mechanic rating? . . . For federal air training

A twelve-man Advisory Committee on Non-Scheduled Flying recently appointed by T. P. Wright, CAA Administrator, will play an important part in drafting the future of personal aviation. This committee will include seven representatives from private flying and one member each from the airplane manufacturers one from the fixed-base operators, one from the airlines one from some group representing consumers, and one from State aviation officials

In order that personal aviation may determine its own destiny Mr Wright has invited interested groups, and also the public, to make nominations to the Committee. Working with the Committee will be four government aviation officials John Geisse, assistant to the Administrator; Jesse Lankford, director of the CAB Safety Bureau, Fred Lanter director of CAA safety regulation; and Jack Nelson of CAA, who will be executive secretary to the Committee

Further strengthening his private flying program Mr. Wright has appointed Mr Geisse as his assistant and advisor in that field. Mr. Geisse's main objectives are the simplification of federal regulations on personal aviation, and the promotion of improvement in light airplane design and utility

Regulation Seen Slated For Non-Operations

Non-scheduled flying including irregular route trips, contract services charter trips and taxi work, constitutes a prospective important field for discharged military airmen. At present, anybody owning a certificated airplane and a commercial pilot's license can engage in non-scheduled business

But regulations are in sight, CAB is investigating all non-scheduled operations and plans For existing non-scheduled services, and many to be organized, will come into competition with the regular airlines, which are under economic control as to their mail, cargo, and passenger rates

It is probable, therefore, that CAA will require non-scheduled operators to obtain route licenses, and will fix their rates But at the same time, CAB wants non-scheduled services in many places, instead of so many licensed feeder lines Watch for CAB decisions on non-scheduled flying

Confusion Won't Curb Drive for Airfields

Construction of smaller class airports is certain to go ahead rapidly when the war ends How rapidly, and how well-planned the fields will be, depends on Congress—also upon many groups, some of which, unfortunately, are giving Congress conflicting information

There are four bills on Capitol Hill, presenting various programs to build about 3,000 airports. In general, all of them call for federal funds to be matched with local funds Cities are fighting with states for control of the federal money—when it becomes available. Most states cannot accept the money until they pass enabling laws.

CAA has presented to Congress a Master Airport Plan, with the intention of planning each field as a part of a national airport system Bureau of the Budget and Federal Works Agency say the Master Plan is not coordinated with the military airport system and that the cost of land is not provided for

All these problems will be ironed out, for nothing will stop the demand for airports. Many ports, of course, will be built by private interests and persons. Meanwhile, Army and Navy restrictions on airport information are being lifted, and CAA will soon resume distribution of its reports and charts on the status of airports

"HIGGINSCOPTER"

Here's Higgins Industries helicopter, shown at a recent display of Higgins products at company's aircraft plant. Designed under supervison of Enea Gossi it seats two side-by-side, is powered by a 180 hp. Warner engine driving a 4-blade 32-ft. dia rotor. Top speed is approximately 125 mph. All metal construction with fabric covering is used. (Wide World photo)

Coming Up

(Meetings and dates subject to wartime conditions under ODT regulations)

Apr. 4-5 SAE National Aeronautic Meeting Hotel New Yorker, New York City

Apr. 10-14 ACCA Airplane Technical Committee (10-11) and National Airworthiness Requirements Committee (13-14), New Orleans.

Apr. 16 International Air Transport Organization Meeting, Havana

Apr. 26-27 IAS Spring Meeting, Horace H. Rackham Educational Memorial, Detroit.

May 16-19 IAS Joint Meeting with Society For Experimental Stress Analysis, Hotel Statler, Buffalo

May 20-27 Pan-American Aircraft Exposition, Dallas.

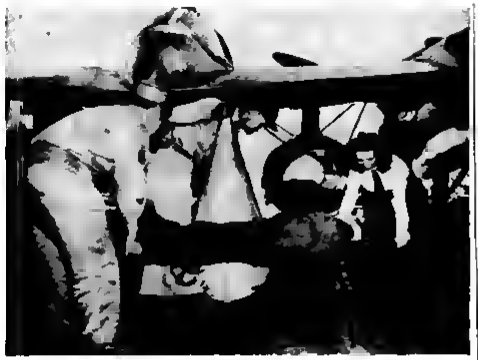
June 4-5 SAE National War Material Meeting, Book-Cadillac Hotel, Detroit.

July (date to be announced): IAS Annual Summer Meeting, Los Angeles.

Oct. (date to be announced)- IAS Air Transport Meeting, Washington

NACA Drafts Statement Of Research Policy

At request of House Select Committee NACA has prepared a statement of research policy, following conferences with the aircraft industry and after appointment of a special



WORLD'S FASTEST AMBULANCE

Lockheed's P-38 Lightning seems to heve no limitations. As being demonstreted here et en AAF Pecific base it has been edepted to carry e litter getiant beneath each wing inside modified wing fuel tanks. Tenks heve e transparent nose end tail cone is detacheble for eese of handling. (Press Assn. photo)

committee and discussion by NACA members.

Preamble states thet since establishment of NACA, value of airplane for national defense and commerce has directly followed evolution of advancing technology based on research; that accelerated enemy research and development created opportunity for aggression which constituted most expensive lesson we have yet learned; and that lead gained by NACA, Army and Navy, and airplane industry shows results which make apparent that further opportunities for substantial improvement in performance of aircraft and equipment can be realized only by vigorous program.

Necessity for research proceeds on belief that it is in public interest to foster increased civil use of aircraft for domestic and international airlines and private operation. Rate and growth of civil aviation is stated to depend on rate of realization of improvements in safety performance, reliability, utility, and economy. Also, that in many cases of war research practical applications have yet to be discovered hence require further research and that airlines and manufacturers cannot be expected to solve these problems quickly without assistance of intensive research and development.

Statement of policy recommends thet AAF Navy Bureau of Aeronautics, CAB CAA, and NACA adhere to general postwar considerations which include provisions holding that fundamental research is principal objective in NACA, research of this organization is not considered completed until results are tested by sufficient practical application, research facilities of NACA may be used to assist government agency in eveluation of specific aircraft or equipment when facilities of agency are inadequate, and may be used to assist private individuals and corporetions in absence of commercial facilities if they bear cost and if investigation is in public interest.

It was also held thet application of research to design of improved aircraft and equipment, civil and military, is function of industry and that encouragement of competitive engineering organizations is essential; expedition of practical use of newly developed aircraft and equipment is function of CAA when government assistance is necessary. Further, NACA specifies contract with university or other private researchers for work in special fields where facilities and competence are available. And in important problems difficult of practical solution parallel attack by NACA, industry designers, Army, Navy, commerce groups, and individual scientists and inventors may be made on various aspects of same basic problem, with coordination achieved by subcommittees of representative experts.

ACC-PAC Status Znoma

With prospects of a substantial postwar personal aircraft industry and airfield program responsibilities of the Personal Aircraft Council of the Aeronautical Chamber Commerce are decidedly on the increase. PAC now numbers more than 20 member firms.

Following appointment of Joseph T Geuting to the post of acting manager of PAC (also see page 223), John E P. Morgan, who retains title of PAC manager, now puts in nearly full time as chairman of the Chamber's management committee. In this position he is responsible under Chamber President Eugene E. Wilson, for ACC's operations.

Don Flower and James C. Welsch have been elected chairman and vice-chairman, respectively, of the Council.

Simpler Mechanic Rating?

National Aeronautic Association says CAB probably will drop aircraft weight distinctions as a basis of reting mechanics. Class One and Class Two ratings probably will be used, but certification would be based on examinations broad enough to test a mechanic's knowledge in both fields, light and heavy.

Far Federal Air Training

A survey conducted by the Aeronautical Training Society, whose members are, or were, flight training contractors to AAF, shows that government-sponsored postwar aviation training is widely favored. The survey indicated that more than 16 percent of men now in the armed forces aspire to careers in aviation. Of those questioned 67 percent favored compulsory military training.

AMERICA AT WAR

Aviation's Communique No. 38

Gen. H. H. Arnold emphasized in a recent speech the major part played by Allied Air forces in breaking up German supply lines and causing their retreat. In the Ardennes push-back, nearly 7,000 enemy vehicles were destroyed by AAF and RAF flyers in two days. Meantime, the Russians continue their grand job of pushing Germany back into a condensed target.

The AAF chief said that Germany does not possess the air power to sustain an offensive. He added that in the Pacific we are setting the stage for full-scale strategic bombardment of Japanese industry. At the same time Lt. Gen. Harmon, commander of Army Air Forces in the Pacific, said that Japan will still be going strong in 1946. American operations during the next 12 months will be aimed at acquiring air bases closer to the enemy's homeland installations, he said.

Nearly all classes of military airplanes will be brought to bear on the heart of Japan when the bases are taken, with action featuring the new high-performance fighter, torpedo, and bomber craft of the Navy. Artemus L. Gates, Navy assistant secretary, recently announced the air arm will soon put into action a jet-powered fighter or fighter-bomber.

Strategic bombing of Jap objectives with B-29's is highly profitable to the Allies, but air attack cannot appreciably weaken the enemy until bomb tonnage is several times multiplied. The Japs will disperse their production, as Germany did, and a high percentage of their airplane output will continue. Quality of Japanese aircraft is improving beyond all expectation. "The fact is that our superiority in aircraft design is being seriously challenged," says Adm. Jr. Witt C. Ramsey, Chief of the Bureau of Aeronautics. And the theory that enemy cities can be burned out has been disproved. Fully 34 fires in Kobe were put out in 24 hr.

Conquest in the Philippines has been helped immeasurably by aviation. The Japs had practically no air observation. American flyers beat them up wherever they showed. Gen. MacArthur had special preise for the 11th Airborne troopers who hiked 35 mi. into Manila from their landing. Air attacks on Britain's lost Singapore have been damaging. Destruction of Jap shipping by air, surface, and submarine attack is still the softest spot in Japan's defense. But the Allies are laying complete plans to fight them on land.

In Germany, war production's success in dodging bombs makes the experts wonder just how much could be done by bombers to a nation that really set out to dig in and take it. But there is no doubt about the value of air superiority in stopping transportation—the Germans had everything they needed for defense and counter attack, but Allies went tactical and wouldn't let them deliver it.

The big air war story, now, is jet power. The Germans outclassed the world in putting JP in the sky; they alone at this writing have jet-powered fighters active. But this time it was their turn to show up with too little, too late. An informed aircraft production official in Washington recently said the jet line might eventually be the biggest item in the U. S. air program. Presumably the British will soon put one or more jet planes into action and it is assumed the Japs will meet the Allies with everything the Germans had in JP.

★ CANADIAN NOTES ★

★ SPOT CHECKING ★

THE WASHINGTON WINDSOCK

by BLAINE STUBBLEFIELD

Next time—If there is a next time—the United States will not have years or months, or maybe even minutes to prepare. Tomorrow's Pearl Harbor may be Chicago or St. Louis just as well as New York or San Francisco or all of them. For next time they'll want to hit us first, while we are weak—to prevent us from getting strong.

Lighter-than-air advocates, still very lively, are urging the Navy to order more blimps. New efforts to obtain government backing for dirigible operations, military and civilian, are in prospect.

Big-city ambitions to be "gateways" to foreign air service will continue to stimulate elaborate airport developments. No city is too far inland to be bitten by the international bug.

A big majority of side-line observers, at the Battle of Washington between "community" corporation and "controlled competition" forces to run American flag foreign airlines, predicts victory for ... One point most debaters forget is that Pan American Airways, when and if defeated, will still hold certificates on most of the world's profitable air routes.

Many helicopter designers, when asked for suggestions on CAA airworthiness regulations in process of drafting, ... knowledge in this field.

The woods will be full of air transport pilots ... Several thousand military pilots will have been trained on equipment to be used postwar ...

Where possible, without in ... hindering war production, the Army distributes aircraft orders ... useful in the postwar market ...

More complications, not less, will beset aviation arts and industries after the war. ... There will be more specialists in aviation than in medicine.

★ CALLING CARDS ★

THESE "X" HURTLERS TEST NEW IDEAS

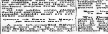
'45 Schedule Asks 82,290 Planes; January Saw Weight Rise; 30,000 Craft Now Surplus

30,000 Craft Now Surplus; More Than 7,000 Sold

January Saw Weight Rise

To "Rebomb" Japan?

Tapering of AWPC Put Off



...s general manager; con... tly both East and West ... divisions are making ... to meet the new mili... needs

...ex Beisel, general manager ... Vought is new president of ... the National Council ... the East Coast division ... Harry Woodhead, presi... of Consolidated Vultee, ... fills vice-president post ... National Council as well ... handling president job for ...st Coast division

★ KNOW-HOWS ★

...of purple glass, air-cooled ...a violet screens are incorpo... ...ed in new Ceilometer used by ...s Weather Bureau to deter... ...ne cloud ceilings. Maker is ...eneral Electric Co. Latter has ...engineered copper mesh to ...place human 'guinea pigs' for ...ting electrically heated cloth... ...under extreme conditions of ...osphere and temperature. ...tective metal works well in ...ulating human temperature ...m

...f sealing tire, tested at ...ight Field by AAF, traveled ...7,100 mi without requiring ...airs after 37mm shell passed ...ough both sidewalls

...s achievements are reported ...helium welding of magne... ...m, and this use has upped ...es of gas to 250,000 cu. ft. ...r month. reports Bureau of ...tes.

...les and machine sorting of ...ish is reported to have saved ...ir over $1,130,000 at Ft ...orth plant in past year.

...matic bomb bay door open... ...chanism, reports Boeing. ...ible figure to keep doors ...sed until last moment, thus ...aying enemy fighter attacks. ...ion operates in 7/10 sec., as ...inst ½ sec. by old method.

...marith X is reported by Cela... ...e Plastics Corp. to be replac... ...aluminum for propeller blade ...tractors used in field by AAF ...ew crews.

...voltage current transmis... ...n to sparkplugs, where it is ...ped up to ignition strength, ...reported by Scintilla-Bendix ...ake for new moisture-re... ...ting ignition system affording ...efficiency performance un... ...r adverse operating conditions

...kelite gear cases for mecha... ...ms retracting landing lights ...d antennas are stated by Plas... ...Research Products to reduce ...ight while retaining desirable ...alities of metal cases.

★ ASSEMBLY LINES ★

...der Secretary of War Potter... ...has written House Military ...airs Committee that delivery ...critical aircraft in last half of ...tt was 9% percent below ...hedule. Further airborne re... ...t was down 4 percent, with ...oduction for first half of 1945 ...19 percent above last 6 ...nths of 1944

...rth American Aviation set ...ord in January by delivering ...8 ships.

...khead's B-17 subassembly ...lit at Pres... has established ...e tactic... aircraft fac... safety re... no production ...having l... least because ...accidents sin... Sept 1943

...epublic Aviation Corp. deliv... ...ered 1,359 P-47's and spares ...equal to 1,430 more in 1944 al... ...most 190 percent increase over ...previous year. New orders now ...bring backlog to more than ...$600,000,000

C-W received orders calling for ...over 50 percent increase in C-4... ...production in last 6 months of ...4a... Company's propeller ...div. has received Certificate of ...Service Award for work in ...AAFTC program.

Douglas is completing new as... ...sembly line at Santa Monica ...plant designed to up C-54 pro... ...duction 200 percent by late sum... ...mer. Studies show that new all-...white paint scheme employed on ...line increases flight values 50 ...percent

Solar Aircraft Co. has signed ...additional contracts with Allison ...div. of GM for production of ...major parts of jet propulsion ...engines

Cleveland Pneumatic Tool Co., ...maker of Aerols, is marking its ...50th anniversary

Goodyear Aircraft Corp., on ...completion of blimp program ...turned all facilities over to air... ...craft subassemblies. New ...orders include Lockheed P-38 ...Grumman F6F, and Boeing B-29 ...parts.

Jack & Heintz is producing all ...types of control equipment for ...jet-planes

Gtinson division of Convair just ...completed its 52nd consecutive ...month of enarokeo on-schedule ...production of L-5 Sentinel "fly... ...ing Jeep."

Ryan backlog for exhaust manifolds has now passed $13,ddd,ddd mark

★ FOR THE RECORD ★

Luscombe Airplane Corp. has ...expanded its manufacturing fa... ...cilities by leasing a three-story ...building at 630 E. State St., ...Trenton, N. J.

Aircraft Accessories Corp. has ...changed name to Aircon Co. ...since its aircraft and electronics ...activities are now expanded be... ...yond meaning implied in old ...name.

Fairchild Engine & Airplane Corp.'s Duramold Div. James... ...town, N. Y., has purchased com... ...plete facilities of American ...Aviation Corp. in Jamestown ...and will transfer entire N. Y. C. ...production there.

General Aircraft Corp., N. J., has acquired Skyfarer Div. of General Aircraft of Delaware, also company's interest in Tennessee Aircraft, Nashville.

York Research Corp., 63 Park Row, N. Y. C., has formed an electronics laboratory. Chief is J. Knox Tillotson formerly with Elastic Stop Nut Corp.

Fisher Body Div. of GM has transferred its aircraft development section to Allison Div., Indianapolis.

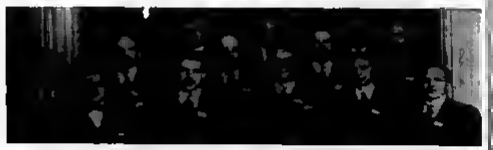
Hoster Aircraft Service, formerly at Huntington, Ind., now operates as Hoster Aircraft Corp., in Atlanta, Ga. Production of aircraft is planned.

Aircraft Sales & Service, Salt Lake Airport No. 1, Salt Lake City, has incorporated to operate flight school, aircraft and engine repair service and sales service.

F. M. Showalter & Associates, 338 N. Michigan Ave., Chicago, announces new aviation advertising, publicity, and public relations service.

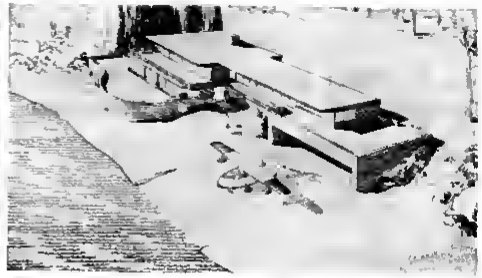
Celanese Celluloid Corp., Lumarith maker, N. Y. C., has changed name to Celanese Plastics Corp.

B. F. Goodrich Co., Akron, has new products dept. in its aeronautical div. to develop rubber, synthetic rubber, and plastics for aviation uses.



ADMA'S "BUSINESS-PILOTS" FDR '45

Seen here is group of new officers and directors of Aviation Distributors & Manufacturers Assn. Front row: R. V. Treder, Bob Trader Aero Supply (vice president); R. Snyder, Snyder Aircraft Corp. (advisory board); T. O. Duggan, Thompson Products Inc. (president); R. N. Bomberger, Sensenich Bros. (vice-president); and L. G. Mason, Aviation Supply Corp. Middle row: R. B. Kenty, Air Associates, Inc.; W. F. Scott, Jr., Supply Division, Inc.; G. E. Wilson, Glidden Co.; R. D. Hicks, Continental Motors Corp.; and R. C. Mueller, Omaha Aircraft Corp. Rear row: T. G. Tynan, Electric Storage Battery Co., G. B. Ven Dusen, Van Dusen Aircraft Supplies; and S. Resbitt, Lear, Inc. G. A. Fernley (secretary-treasurer) and H. P. Ladds are not shown.



ORLY A SKIP AND A JUMP—FOR A HOP

Mighty alluring is this conception of postwar dwelling or of waterfront country club with attached hangar for personal plane. Sketch is by R. H. Edwards of Republic Aviation Corp.'s engineering staff. Craft shown is company's postwar Seabee amphib.

American Society of Lubrication Engineers, a non-profit body, has opened headquarters at 16a So. LaSalle St., Chicago.

Onerud Machine Works, 3008 Palmer St., Chicago, spar milling machine manufacturer, reports completion of a two-story addition to plant.

Rohm & Haas Co., Plexiglas maker, has moved N. Y. C. offices to larger quarters at 11 W. 42nd St.

Loer, Inc., has opened an aircraft radio repair shop at Grand Rapids, Mich., Municipal Airport. In charge is Hal Sagert.

Specialties Mfg. Co., Bloomfield, N. J., wholly-owned subsidiary of Walter Kidde & Co., has been renamed Kidde Mfg. Co., Inc. Headquarters remain in Bloomfield.

E. J. Tedlebue Mfg. Co., maker of industrial control and laboratory instruments, has sold assets, goodwill, name and patents to Portable Products Corp., Pittsburgh, Pa., which will operate business as separate division.

Teckna-Plastics Co., 226-01 N. Boulevard, Bayside, L. I., N. Y., has changed name to Teckna Co.

Gerotor May Corp., Baltimore, Md., maker of oil and hydraulic equipment for machine tools, has acquired Cotner Machine Prod. Co., Logansport, Ind.

Aerovox Corp. has changed ownership and management. New president is W. Myron Owen.

U. S. Gauge Co., Sellersville, Pa., has moved Chicago office to Monadnock Block, 53 Jackson Blvd. Office is headed by Walter H. Magee.

Doehler-Jarvis Corp. is name of consolidated company formed by merging of Doehler Die Casting Co., N. Y. C., with W. B. Jarvis Co., Grand Rapids, Mich.

Hercules Powder Co. has established cellulose products department Chicago office as regular branch office. In charge is Fred K. Shankweiler.

Hawthorne Airmotive has been chartered at Orangeburg, S. C., to conduct a flying service and merchandise planes and parts. B. E. Howard is president.

Mail-Pay Order Shakes Transport Revenue Setup; UAL, AA Protest CAB'S Show-Cause

. . . World-route hearings end; permits in prospect . . . New bills also to solve legislative puzzles . . . CAB seeks airline powers . . . Examiners' Atlantic plan supports competition.

Revenue structure of the entire air transport system is affected by CAB's order to UAL, TWA, EAL, and AA to show cause why their present air-mail pay level of 60c per ton-mile should not be cut nearly in half to a 32c level. Each line received a separate order. A fifth document institutes a general investigation by CAB of air express and cargo rates.

In these show-cause orders the board makes an important departure from its usual formula of basing rates on company investment, and it indicates clearly that it will consider separately the operators' mail revenues as distinguished from other income.

United, which had already announced intention to reduce passenger fares, protested the order, contending that public interest would be better served if company profits are shared with air travelers. American Airlines later proposed a passenger fare cut of 6½ percent, as compared with UAL's proposed average reduction of 10.1 percent, and formally called upon CAB to modify or vacate its show-cause order.

The 32c-per-mile mail-pay level suggested by CAB is a bargaining minimum; the final rate is expected to be higher.

World-Route Hearings End; Permits in Prospect

Hearings on all sections of the world U S flag system, mapped last year by CAB, have been completed, and some permits will be issued this year. Domestic airlines and shipping companies have filed applications for far more overseas mileage than estimated traffic will justify.

President Roosevelt was expected at this writing, soon to proclaim adherence of this government to agreements reached at the International Civil Aviation Conference held at Chicago. After that, it is believed at the State Department quick approval by the other 26 nations needed, will be forthcoming. Right of transit over foreign lands, right to land for fuel and services already granted by more than 30 countries will obviate the need for tedious negotiations on many proposed routes. The right to pick up traffic, outward and homeward bound, will be subject to long negotiation between most countries. Britain, seeking closely controlled competition as opposed to U S desire for free competition, has not approved of the Chicago agreements.

New Bills Aim to Solve Legislative Puzzles

Unsolved prewar air legislative problems, now combined with war and postwar domestic and foreign enigmas are being tackled by Congress with a large number of bills.

Chief among these is a new bill (HR 674) by Rep Lea incorporating most of the old defeated Lea measure. Added is a federal airport financing measure. Other features would provide for a Civil Aeronautics Commission and an Air Safety Board independent of the Commerce Department, limited regulation of contract carriers, uniform zoning standards, appropriations for civil pilot training; strong government control over all civil aviation, a Post Office inquiry into the merits of carrying all first class mail by air, and laying out of a national feeder line system for postwar.

Unlike last year's bill, it omits extensive provisions on American flag foreign air transport, and on auxiliary air services by surface carriers. Strong pressure is being brought by various interests to break down this Lea bill into several bills.

Second is Sen McCarran's proposal of an "American Flag Line" foreign system in which most carriers would be authorized to own stock (the "chosen instrument" idea). It is opposed by all government executive agencies and by all airlines except Pan American and United. It has some strong support in the Senate, less in the House.

There are the usual bills to set up Divisions of Air, Army, and Navy under a Department of Defense, one to investigate electrical storms, one to provide for study of jet propulsion. Also proposed construction of 3,000 new airports is incorporated in several bills. Mr Lea has promised that his House Commerce Committee will study the air cargo situation.

CAB Seeks Airline Powers

Congress was asked by CAB for authority to control airline schedules and equipment, as well as routes and route extensions. Economic regulation of the airline system is based on a policy of controlled competition. The Board feels that it cannot carry out this policy completely unless it can determine how many and how many airplanes various lines may put in service. The request will be passed upon in connection with one of the several bills before congress providing for revision of the Civil Aeronautics Act of 1938.

CONVAIR'S MODEL 37 — POSTWAR GIANT

First photo of model of 204-passenger over-ocean transport currently under development by Consolidated Vultee Aircraft Corp., and on order by Pan American Airways. In addition to passengers, craft is designed to carry 15,300 lb of mail and cargo and will have maximum range of 4,200 mi. Both staterooms and berths will be provided for over-night travel, and craft will be powered by six pusher engines now in development stage.

Examiners' Atlantic Plan Supports Competition

CAB examiners have, meanwhile, submitted their recommendation to the Board in the postwar overseas expansion plan. It suggests that American Export and United share the North Atlantic traffic. The examiners ask that domestic lines be not allowed to operate overseas routes through corporate affiliaries, and thet international carriers be given access to interior U S traffic. The report strongly re-affirms CAB's stand for competition on American flag lines, but concedes the practicability of single operations on routes serving light traffic regions.

★ CROSS COUNTRY ★

Fifth allocation of surplus airports by SPB gave U. S. Airlines more planes: Alaska Airlines, 2; AA, 1; C&S, 1; Braniff Airlines, 1; Nevada-Southern Airways, 1; and PAA and Panagra, 1 each.

UAL has begun educational program covering prospective finance work on Douglas DC-4 and DC-6 equipment to be used in postwar, with distribution of special circulars among maintenance crews. Airline is also considering questions of service and meal which will be needed; how to assign spare parts to various routes, what training will be required for key maintenance men, and how maintenance schedules may be revised to conform with new procedures.

Westchester County Airport near White Plains, N. Y., was recently opened officially for promotion of private flying. Its main purpose, though approaches to the city can serve largest transport ports now in use. Operation of this county-owned project is by North American Airport Corp., with parent Gulf Oil Corp. as dispenser of petroleum products.

AA has formed an air freight project group to handle technical phases of its air cargo program.

Aviation insurance interests are conferring with ATC and AAF officials regarding accident insurance rates for planes using ATC planes.

PAA has exhibited schedules showing reduced flying times planned between U. S. and Pacific islands, saying fares will be lower in many cases than minimum first class fares of surface carriers. Listed are: Los Angeles-Sydney, 32 hr., $295; San Francisco-Shanghai, less than 60 hr., $305; Seattle-Tokyo, little over 20 hr., $309 and $

...4 hr., $55 . . . Clip... record 1,120,664 lb. ... in 406 Atlantic crossings ... 1944 . . . Low cost spe... commodity rates for fresh ...ultry, and meat were ... between Puerto Rico ...inican Republin to aid ... food shortage in P. R. Daily Clipper flight was ... between Miami and Hav... Subsidiary Compania ... Cubana de Aviacion, ... received Inter-American ... Council award for com... 10 years of operation ...t fatalities.

...f Airways filed applica... with CAB to create new ... east of Memphis to At... by way of Chattenooga, ... east of Memphis to ... Phila., and N. Y. C., via ...nooga, Charlotte, Raleigh, Norfolk . . . Colorado, Okla... and Texas are now served ...s, with connections to and ...Mexico . . . Oklahoma City ... route is reinstated.

...Continent will begin Kan... New Orleans flights when ...ted surplus transports by ...

...CA de Colombia, associated ...CA line with Aq in Bogota, ... awarded operating permit ...Colombian government.

...ank Steamship Co. of San ... filed application with ... to operate air service be... West Coast and Australia ...Honolulu.

...Oriental Air Lines has opened ...er - Wichita - Tulsa route, ...g DC-3's . . . Applications ...CAB ask for Denver-Kan... City-Chicago and Denver... City-St. Louis routes.

Spencer A. Larsen, director ...air cargo research, Wayne ...versity, cited need for pro... growers to cooperate with ... in timing of harvests ...n distribution and manne... supervising procurement of ...ties for air-shipment.

...Life Assurance Society ...ots pilots and air crews of ... airlines as eligible ...ordinary life insurance at ...slight extra premium of $5 ...$1 000

PCA inaugurated 18 daily flights between Chicago and Detroit, including 7 nonstop flights . . . Company has applied to CAB for routes between U. S. and South Africa at rates comparable to domestic air travel, planning to use Douglas DC-4's to make trips in 48 hr.

★ AVIATION ABROAD ★

British Ministry of Aircraft Production has ordered an undisclosed number of Miles M-60's for feeder lines. Type will be 4-engine all-metal 14-passenger monoplane with 1,000-mi. range.

Australian government will start direct air service to Britain soon. Beginning as a weekly service, it is hoped to build route up to seven flights a week.

Japs say they are equipping home defense fighter units with new "Hie Ang" (flying swallow) planes especially designed to carry out ramming-type attacks on B-29's.

Egyptian government states it will retain full sovereignty over airfields in country. Premier Maher Pasha is quoted as saying air bases built by U. S. and Britain will either be taken over or not permitted to continue operations.

British plan to work out empire agreement controlling air routes within Commonwealth if new efforts to reach an international agreement on postwar commercial aviation fail.

Britain has now dropped balloon command which maintained famed balloon barrage while Luftwaffe was a major threat.

Mexico has selected an air squadron to receive special training in U. S. with complement of 900 pilots and crew members under command of Maj. Salvador Noble Morales.

Obituaries. Marcel Doret, speed flyer and test pilot. In 1924 he won world's speed record, flying 621-mi. course at 188-mph. . . . Marcel Olivier, former chairman of Air France Transatlantique.

VERTICAL DELIVERY FOR JEEPS AND GUNS

...here is belly of Halifax bomber fitted to drop jeep and anti-tank gun ... to British airborne troops in western front operations. Installation includes support for heavier part of equipment, provision to counteract of takeoff and flight, device to keep units horizontal during drop, ...shock absorbers under wheels. Weight is allocated as 3,700 lb. for a gun, container, and chute, and 3,600 lb. for jeep similarly ...Maj. Gen. Lewis H. Brereton, of U. S. airborne forces, is seen ...installation, which projects below fuselage during flight. (British photo)

Beech Aircraft Corp. reports sales of $90,103,175 for the fiscal year ended Sept. 30, 1944, an amount slightly higher than sales of $89,826,000 in the preceding year after final renegotiation. Net income amounted to $2,705,461 or $6.76 a common share, compared with $2,216,596 or $5.54 a share in 1943. Pres. Beech said that a reserve of $16,879,381 was set aside from 1944 earnings as a renegotiation liability, although renegotiation proceedings had not been started.

Delta Air Corp., paving the way for its postwar expansion, has declared a 25 percent stock dividend and arranged for the marketing of 102,424 shares of new common stock. Proceeds from the stock sale will be used to purchase equipment and to finance ground facilities and general expansion. The new issue and the stock dividend brings total outstanding shares to 400 000 of 500,000 authorized.

Preferred Retirements: Solar Aircraft preferred holders have converted 27,101 shares into common stock on a one-for-one basis. As of Jan. 15, there were 38,961 preferred shares unconverted out of 80,000 shares originally issued. . . . All American Aviation has called for redemption its 25,758 shares of preferred, each of which are convertible into five shares of common stock.

Backlogs: Curtiss - Wright's unfilled orders are unofficially estimated at nearly $2,000,000,000. . . . Sales for 1944 are placed in the neighborhood of $1 600,000,000. . . . Republic Aircraft's backlog is estimated at around $600,000,000 with 1944 shipments approximating $400,000,000 . . . Ryan Aeronautical has a $13,000,000 backlog in the manifold division, and total contracts exceed $80,000,000

Sales: Grumman's shipments in recent months are reported at around $30,000 000. . . . Douglas produced more than $1 000,000 000 worth of aircraft for the second consecutive year in 1944. . . . Northrop sales for the fiscal year to end in July are projected at about $80,000,000

Sendix Helicopter is issuing 400 000 shares of stock to provide working capital for production of 400 helicopters a month." Stockholders will be offered 1,000 000 shares on the basis of four additional shares for each five held at $1 50 a share, and unsubscribed shares will be sold to the public at $2 a share The remaining 400,000 shares will be reserved to provide for certain stock options.

Solar Aircraft reports net earnings of $442,473 or $1.34 a share for the six months ended Oct. 31, against $514,974 or $1.57 a share in the like '43 period Sales were $14,750,002 against $12,273,588 the previous year

Aircraft Accessories Corp. reports net profit of $1,064,040 or $1 49 a share for the fiscal year ended Apr. 30, 1944, compared with net profit of $741,433 or $1.21 a share in the previous fiscal period Net sales were $38,316,830 against $20,631,469 reported in '43.

United Air Lines announces net earnings of $5,194,509 or $5.23 a share for the nine months ended Sept. 30, against $3,305,141 or 77c in the like 1943 period. Pres W. A. Patterson said that the company has sufficient cash to meet its recent purchase of 50 transports.

Cessna Aircraft reports net sales of $40,385,571 for the fiscal year ended Sept 30, 1944, against net sales of $70,729,401 in the preceding year Net profits were $1,102,035 or $1.57 a share, against $2,208,414 or $3.15 a share in 1943. During the year the company changed over from production of trainer and cargo planes to major component assemblies for tactical bombers, according to Pres. Wallace.

Waco Aircraft reports net sales of $12,046,603 and net profit of $106,543 for the fiscal year ended Sept. 30, 1944. Pres. Bruckner said that there was no lessening in demand for the company's products A new war ilam is just getting into volume production.

Thompson Products plans to issue 30,000 shares of common stock and will use the proceeds for general corporate purposes. The Euclid, Ohio, plant of Thompson Aircraft Products Co., a subsidiary, may be purchased from the government.

Aeronca Aircraft Corp. has issued 75,000 shares of preferred stock and 33,600 shares of common with the net proceeds of around $732,000 to be used initially to strengthen working capital, with later utilization in prospect for plant expansion.

Piper Aircraft Corp. reports sales of $10,646,171 for the fiscal year ended Sept. 30, 1944, as compared with net sales of $11,478,597 in the preceding year. Net profit was $259,676, against $316,258.

National Aviation's 1944 report reveals that the company sold 7,770 shares of Bell Aircraft, 600 shares of Boeing, 500 shares of Uniten Aircraft, 3,200 shares of Braniff, 2,000 of Mid-Continent Airlines, 1,500 shares of Pan American Airways, and 3,600 shares of Pennsylvania - Central preferred stock last year Purchases included 1,400 shares of Douglas, 3,100 Grumman, and 15,000 of Republic.

ADDING IT UP.....By RAY HOADLEY

As National Aviation Sees It. Because of their outstanding success in managing the largest aviation investment concern, the annual report by National Aviation Corp officials is always of interest. Their current report shows that National increased its aircraft and accessories stock holdings from 35.5 percent in 1943 to 38.6 percent of its total portfolio last year, while airline holdings jumped from 24.2 percent to 22.2 percent, cash assets were down to 14.6 percent from 22 6 percent, and holdings of non-aviation industrial stocks declined to 14.3 from 22.6 percent.

The Manufacturing Outlook. In discussing the aircraft industry, the report pointed out that the manufacturers had their first widespread experience last year with cutbacks of contracts and also contract terminations. Difficult as this experience may have been, the report continued, it advanced practical preparations for the inevitable large-scale cancellations which all companies face eventually. The progress made in controlling inventory and other expense was cited, and the significant conclusion was drawn that "liquidation of war business in itself does not necessarily represent an insurmountable financial hazard."

Airline Prospects. Turning then to the airlines, the National officials pointed out that while air traffic volume is bound to grow, the airlines have problems to meet that can become "very disturbing" to their progress from time to time These problems were listed as (1) Reduction in mail rates, (2) voluntary reductions in passenger rates, and (3) unfavorable results if excess profits tax exemptions are exceeded by some lines. These problems may be succeeded by others, such as the return of point-to-point competition as equipment availability catches up with demand and load factors begin to decline.

Using the T-Loans. War contractors have paid little attention to the T-loan facilities which the government has offered as protection against terminations. So far only about 100 concerns have taken out such loans (to a value of around $82,000,000) Prospects of a longer war and a provision in the contract settlement law calling for a 30-day mandatory payment of between 75 and 90 percent of the settlement amount are cited as reasons why contractors have delayed taking these loans.

Warning to Subcontractors. The subcontractor is the one who may really need T-loan protection. In applying to his prime contractor for termination payments, his application must be in "proper form" and must be supported by a certificate not inconsistent with known facts and figures. Conforming with these requirements may run into delay and "contractor resistance" So the subcontractor may find that the mandatory payments he is counting on may take considerable time.

Airline Financing. Rumors of airline financing are more prevalent than ever in Wall Street, with reports telling of two large lines weighing the advantages of bank credit against stock flotations as a means of financing plane purchases. TACA and Delta Air Corp are two other companies said to be planning to raise capital.

BRIG. GEN. VICTOR E. BERTRANDIAS is new chief of maintenance for ATSC. He will direct AAF's worldwide maintenance and overhaul operations from his new post at Wright Field, Dayton. A former vice-president of Douglas Aircraft Corp. In World War I he served with famous 94th pursuit sq. (ATSC photo)

FURLONGE H. FLYNN has become service mgr. of P&W Aircraft, Div. of United Aircraft Corp. Previously asst. service mgr., he first joined P&W in 1929 and he served abroad as company field supervisor, setting up divisions' foreign service organization, becoming secretary of United Aircraft Service Corp. in '42.

IRVING B. BABCOCK is new pres. of The Aviation Corp., succeeding Victor Emanuel who became chairman of the board of directors. Mr. Babcock was formerly pres. of Yellow Truck & Coach Mfg. Co. and has served on WPB, ODT, and ACWP. As Avco president, he will be in charge of 29 operating divisions.

JOSEPH T. GEUTING, JR., has been named acting manager of Personal Aircraft Council of Aeronautical Chamber of Commerce following assignment of John E. P. Morgan to broader duties in ACCA. To accept new post, Mr. Geuting resigned his position as vice-president of General Aircraft and chairman of P.A.C.

GORDON C. SLEEPER has been appointed sales manager of Personal Plane Div. of Public Aviation Corp. In addition to new duties of organizing domestic and foreign sales of company's new amphibian he will continue as director of public relations handling advertising, publicity, and sales promotion. (R. H. Costain photo)

CHARLES L. "LES" MORSE has joined Bendix Helicopter, Inc., in connection with company's rotary wing development. Veteran of many "firsts" in this field, he is director of field operations with supervision over flight testing, deliveries, and field servicing. He is author of "Pioneering the Helicopter." (McGraw-Hill)

FREDERICK W. MOORE is new general production mgr. of C-W propeller div. at Caldwell, N. J. "A native of Detroit and graduate of University of Michigan, he was formerly with Ainsworth Mfg. Co., Dodge Div. of Chrysler, and Motor Products before coming to C-W, where he became planning supervisor for division.

WILLIAM L. WILSON is new vice-pres. of Kellett Aircraft Corp., where he will handle all public relations work. He has been asst. to pres. of company since Nov. 1943 and prior to that dir. of public and industrial relations for Republic Aviation Corp. He was formerly a Phila. newspaperman and is a member of AWA.

RILS R. LOU, formerly factory mgr., is advanced to asst. to vice-pres., manufacturing, at Glenn L. Martin Co., Baltimore. He joined Martin organization as a tool maker in 1929, then he successively became tool room foreman, assistant chief tool designer, and chief tool designer. Then he became factory manager.

EDWARD S. KITTEL is superintendent of Convair's newly created Ft. Worth dept. for B-32 Dominator modifications. Formerly asst. plant mgr. of div., he joined Convair in 1941 as chief construction engineer. He is a 1929 civil engineering graduate of VMI. When war came he was pres. of Eastern Construction Co.

A. HOWARD HASBROOK is new sales engineer for Aeronautic Aircraft Propellers, Bartlett-Hayward Div., Koppers Co., Baltimore, Md. His duties include flight demonstrations and promotion of automatic propellers in company plane as well as general sales work. He recently completed 11-month tour for AAF.

FRED E. WEICK (*left*) received *Sylvanus Albert Reed Award* for 1944 from IAS for his contribution to development of tricycle landing gear and of two-control non-spinning airplane. He has been closely associated with NACA since 1925, and in 1936 he joined Engineering & Research Corp., of which he is chief engineer. CDR. BEN E. KELSEY (center) was presented with Octave Chanute Award for 1944 for his work in development of high speed military aircraft and his studies of effects of compressibility through flight testing. A graduate of M.I.T., he specialized in mechanical engineering and holds B.S. and M.S. degrees. Lawrence Sperry Award was given to WILLIAM R. PHILLIPS (right) for contributions in field of aircraft stability and control. He is head of NACA Langley Memorial Aero Lab.'s stability and control flight test section where he has directed work of 29 project engineering including stability and control tests of new airplanes. He graduated from MIT and received aero. engineering science degrees in '40.

CHARLES R. CHILVER of New York was elected president of IAS for 1945 succeeding Maj. R. M. Fleet. Holding a pilot's license from Federation Aeronautique Internationale, he learned to fly in 1925. Past associations include founding of Pioneer Instrument Co. and directorship of Guggenheim School of Aero.

We wish some scientist would explain that very strange gastronomic effect that fast-flying long-range planes have on public relations men. Just fly one of these craft from somewhere to somewhere else and a cryptic culinary light shines in their eyes. Then they grab their typewriters and out comes— " . . . Now you can eat an early lunch on the West Coast and have supper on the East Coast! . . . After a midnight snack in New York this plane will set you down for bacon and eggs in San Pedro! . . . Just have your piping-hot *pilaff* in Persia, then hop—only a couple of hours in this sky-cruiser and they'll serve you spaghetti in Spezia!" . . . *ad infinitum*. Seems the minute this hex hits 'em, it's all a matter of going somewhere else to eat.

We find ourselves wondering if flush rivets somehow catalyze Alclad and combine chemically with long-range skis to produce this dietary hypnosis? We guess it couldn't be that. But whatever it is, we find it downright pathological—probably because we're perpetually short of ration points. Maybe this pixillation could at least be transmuted into some other pursuit besides eating. It'd sorta be a pleasant change to read " . . . And now you can kiss your wife good-bye in Chicago in the morning and go smooching in Somaliland in the afternoon."

Fellows on a supply flight over the Pacific had become conscious of an annoying buzzing sound coming from a couple of depth bombs in their ammo cargo, and not liking it a bit, they contacted base for advice. Substance of the reply they got was, "Think nothing of it." But they kept thinking something of it anyhow, and finally they muscled the two 500-pounders out into space—where, even before hitting the water below, the charges burst with a terrifying *WHAM-M-M-M!*

Five minutes later, as respective pulses again neared normal, there came a call-back from base: "Change in earlier message regarding depth bombs to . . . Further consideration indicates defects . . . Jettisoning of charges is suggested."

Certain aviation leader—whom in this instance we'll favor with anonymity—was at Wright Field casting an interested eye over the Bell P-59 Airacomet. And like anyone else he was especially intrigued by the craft's jet motors. So he half knelt to gaze into the hind end of one of the whoosh units —just at the precise second that the 75-mm. cannon on a B-25 roared into action on the firing range at the other side of the apron. Anyway, fast thinking industry exec went flat on his face in the grass. It was in the following second that he realized the jet engine *hadn't* opened up.

• One of our more lugubrious friends comes up with his own definition of what he fears may become our postwar air commerce policy—one of "reasonable strangulation of free competition."

• Suggestion committee chairmen don't always lead the dull dig-away life they're often supposed to. One of them recently got a properly filled out blank —complete with very professional drawings—which said: "I would suggest you put an umbrella over my drill press. It should be of stout canvas, and at least four feet in diameter. Around the edges should be placed a small gutter (this could be made of scrap metal) with a drainpipe running into a pail placed beneath the metal stand. Either that or fix that lousy leak in the roof right over my machine."

• In that same plant one man, with a long and complicated name, was constantly being paged over the public address system. A suggestion form said, simply, "If you want the rest of us to get any work done equip Mr. So-and-so with a walkie talkie."

• Anent promotion of airparks, stopa, ports, etc., we note that one of our estimable contemporaries headlines that 2,196 U.S. airports have "hangers." Well, since there aure is a lot of work to be done it'a right nice to know there's a place to hang the old coat.

"Maguire's showing off again—wants everybody to know he made a trip down under to Australia."

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquirits to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Aircraft Rectifier System automatically keeps temperature of plates in range where resistance of unit is relatively low so that voltage drop through rectifier is low and only relatively small range of variation of input voltage is necessary to keep output voltage constant, thus permitting use of small lightweight voltage regulator. Rectifier has cooling means controlled in accordance with voltage drop, to keep temperature in range where voltage drop and required variation in input voltage are relatively small.—2,391,248, filed Oct. 13, '43, pat. Oct. 23, '44, C. G. Yelcott and R. J. Braun, assignors to Westinghouse Electric & Mfg. Co.

Airplane Wing Design omits camel shaping ribs, their function being performed by plurality of reinforcing members forming part of load-carrying structure. Upper and inner edges of front and rear spars are formed with flanges lying in wing surfaces, and reinforcing members extend alternately in opposite acute angular directions between spars to provide triangulated truss structure. Ends of reinforcing members being overlapped and secured to spars.—2,392,686, filed June 3, 39, pat. Nov. 7, '44, C. W. Snyder, assignor to Engineering & Research Corp.

Wing Mounting incorporates rotatable beam and cylinder and piston arrangement for moving airfoil about longitudinal axis into various angles of attack to control flight, each wing being controlled independently of other for maneuverability, and both being operative together. Piston is cushioned between limits of movement to yield to shocks transmitted to wing and to restore latter to position for normal flight.—2,392,214, filed Nov. 2, '42, pat. Nov. 7, '44, G. Roseland.

Rotary Wing for helicopters and autogiros is partially constructed of plywood or similar semi-rigid material, and it is braced to secure utmost strength for weight, particularly in direction of component of centrifugal forces applied during rotation. Blade has hollow interior in which are located plurality of tension members adjustable to compensate for pre-stressing, shrinkage, and warping, and extending substantially throughout blade length. Metallic stub spar extends from hub, has crenelated spar connector sleeve rigidly mounted thereon, and box spar enclosing the sleeve.—2,392,261, filed July 17, '42, pat. Nov. 7, '44, J. S. Pecker.

Dive Bomber Design provides for housing bomb load within wing contour having movable skin panels automatically actuated to open for passage of bombs and for subsequent return to contour-forming position.—2,392,249, filed June 25, '41, pat. Nov. 7, '44, E. M. Bertran, assignor to Brewster Aeronautical Corp.

Bomb Checking Device comprises bracket member consisting of pair of oppositely flanged plates with directionally aligned face portions adapted for clamping against supporting surface of plane. Device is intended to automatically adjust and lock in checking position and resist tendencies to retract in response to forces imposed by bomb load.—2,392,261, filed Dec. 17, '41, pat. Nov. 7, '44, L. R. Davis, assignor to Brewster Aeronautical Corp.

Aircraft Cowling Construction aims to increase accessibility to engine by providing sectional encircling cowling descountable as a whole for opening entire engine compartment for inspection from all sides. Multiple sections are detachably interlocked for ready dismantling, and joints are brought flush by action of camming lugs provided on fastener stud.—2,392,821, filed Oct. 26, '43, pat. Nov. 7, '44, W. F. Lawry, Jr., assignor to Brewster Aero

Review of Patents

By A. HARRY CROWELL, *Registered Patent Lawyer*

Air Drag Landing Device intended for use in short or emergency landings consists of parachute housed in tail chamber of plane, with release-means operative from cockpit to open chute behind plane for braking action.—2,392,792, filed Aug. 20, '43, pat. Nov. 20, '44, G. C. Jenkins.

Airplane Wing is designed to decrease or increase drag to obtain greater speed or more lift by using main frame connected to resilient skeleton frame having plurality of spaced resilient strips with means for flexing to distort wing and effect a change in camber.—2,366,946, filed Feb. 22, '42, pat. Nov. 28, '44, E. V. Smith.

(*Turn to page 349*)

Book Reviews

AERODYMAMICS, by L. R. Parkinson. The Macmillan Co., N. Y. C. 212 pages, illustrations, graphs, index. $2.25.

Compact exposition of the science of flight. Sub-topics discussed are physical properties of the atmosphere, airstreams, Reynolds Number and also the Bernoulli Theorem, lift and drag, airfoils, lift-increasing devices, performance, stability, propellers, and wind tunnels. There is a minimum of mathematics. Full reference tables are included.

OUR FLYING NAVY, introduction by Secretary of Navy James Forrestal. The Macmillan Co., N. Y. C. 170 pages, includes 80 full-color reproductions. $3.75.

This 9¾- by 13¾-in. book presents a large canvas not only for a lucid text reflecting the history of naval aviation in the present war but also for an excellent series of color drawings that depict its many-sided life. A montage of planes at sea and of the people who make and fly them.

CLOUDS, WEATHER AND FLIGHT, by Thomas C. Gillmer & H. Erich Nietsch. D. Van Nostrand Co., N. Y. C. 161 pages, illustrations, graphs, tables, glossary. $3.75.

Presentation of problems of aviation and meteorology, and their inter-relations, in a world of three dimensions. Graphic illustrations give much interesting data on the subjects. The volume, largely non-technical, is addressed to both pilot and layman.

THE WAGING OF PEACE, A Program for the Air Age. American Association of School Administrators, Washington, D. C. 48 pages, 25c.

Educational statement of the fundamental factors of aviation and of the coming air age, prepared for use by teachers and students. The important role of aviation in the post-war period is calculated.

TEAMWORK AND LABOR TURNOVER IN THE AIRCRAFT INDUSTRY OF SOUTHERN CALIFORNIA, by Elton Mayo & George F. F. Lombard. The Harvard Business School, Boston. 32 pages, tables, graphs, $1.

Study of the labor status in one of our great aviation centers, detailing effect of wartime complexities and with special consideration of the problem of absenteeism.

GAS TURBINES AND JET PROPULSION FOR AIRCRAFT, by O. Geoffrey Smith, Aeroengines, M. W. C. 124 pages, drawings, photos. $2.00 (paper) and $3.00 (cloth).

Revised and broadly enlarged with much new material, this work presents a comprehensive and timely survey of thermal jet propulsion systems, with detailed treatment of rotary, reciprocating or combined units, steam and gas turbines, driving airscrews, etc. (Initial smaller volume was reviewed in May 1944 AVIATION.)

PIONEERING THE HELICOPTER, by C. L. "Les" Morris, McGraw-Hill Book Co., N. Y. C. 161 pages, drawings, photos. Foreword by Igor I. Sikorsky. $2.75.

Here are revealing details of the development of the Sikorsky helicopter, of subsequent Wright Field trials of the craft, and of training of copter pilots, written by a man who, as Sikorsky chief test pilot, was closely identified with these projects. Particularly good are the author's many clarifications and expert estimates of the helicopter, in view of the many misconceptions extant. (Chapters regarding pilot training and the future of the craft, respectively, appeared in the August and November 1944 issues of AVIATION.)

THE AIRCRAFT ANNUAL—1945, by David C. Cooke, Robert M. McBride & Co., N. Y. C. 288 pages, photos. $3.

With nontechnical approach, this volume considers the current aircraft highlights. Essentially for popular appeal, it offers a coverage of present designs and types.

AIR NAVIGATION—Part 7, McGraw-Hill Book Co., N. Y. C. 188 pages, drawings, appendix, index. $2.00.

Seventh in this aviation series, this book deals with nautical astronomy and celestial navigation. Subjects include fixing of position by celestial sights, nature of astronomical time, determination of when the sun and second star set, and location of principal navigational stars.

MANUAL OF AIRCRAFT LAYOUT, by Rudolph Faltus and Charles Steinmetz Willey & Sons, Ltd., New York-London. 240 pages, drawings, tables. $3.00.

Designed as a textbook, manual, and reference in factory and school, this work focusses upon use of drawings for imparting information.

NEW METHODS FOR SHEET METAL WORK, by W. Cookson. The Technical Press, Ltd., London. 208 pages, drawings, index.

Working textbook for apprentices, sheet metal workers, platers, and draftsmen engaged in engineering, aircraft, shipbuilding, and allied industries.

METALS AND ALLOYS DICTIONARY, by M. Merlub-Sobel. Chemical Pub. Co., Brooklyn, N. Y. 236 pages. $5.50.

Reference work containing definitions of metallurgical terms and information on composition, properties, and uses of the important commercial alloys. Also given are physical constants and properties of chemical elements as well as descriptions of machinery and processes used in modern metallurgy.

AIRCRAFT MECHANICAL DRAWING, by D. J. Davis and C. H. Geen. McGraw-Hill Book Co., N. Y. C. 245 pages, illustrations, glossary, appendix, and index. $2.50.

Intended for the student without previous training in mechanical drawing, this textbook deals with essential principles and skills required for a knowledge of practical aircraft drafting.

THE PHYSICS OF FLIGHT, by Alfred Lemke. Reinhold Pub. Corp., N. Y. C. 122 pages, graphs, illustrations, appendix, formulas. $2.50.

Presentation of the basic principles of airplane flight in condensed form. With less essential material eliminated from the text, the book's aim is to "provide a framework which students of engineering and physics can utilize in attaining a thorough knowledge of aerodynamics."

QUESTIONS AND ANSWERS FOR AIRPLANE AND ENGINE MECHANICS, Whittlesey House, McGraw-Hill, N. Y. C. 302 pages, $4.00.

Presents 2,822 questions and answers forming a comprehensive compilation of practical and theoretical knowledge required by plane mechanics and airplane engine mechanics.

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KEEP POSTED ON

Products and Practices

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

BEARINGS RATA

High Capacity Ball Bearings.....1

Covering new list of recommended sizes, bulletin No. 105 titled *High Capacity Ball Reciprocating Bearings*, issued by the Torrington Co., Bantam Bearings Div., South Bend, Ind., gives operating capacities per row of balls for 100 rpm based on average life of 3,000 hr. Also included are other pertinent data.—AVIATION, Mar., '45.

Electrical Equipment Catalog.....8

Containing photographs and listings of products not shown in previous issues, new abridged catalog is offered by Square D Co., Detroit. Line includes safety switches, service equipment, circuit breakers, panelboards, bus and feeder ducts, motor control and pressure switches.—AVIATION, Mar., '45.

Steel Plate Fabrication.....2

Bases, columns, and frames of machine tools, fabricated from steel plates, are described as having advantages of rigidity, durability, adaptability, appearance and economy, in circular issued by Central Boiler & Mfg. Co., Detroit.—AVIATION, Mar., '45.

Screw Thread Fits.....4

Information for engineers in *specifying* for screw threads is offered in booklet from Greenfield Tap & Die Co., Greenfield, Mass. Title is *Guide to Screw Thread Fits*. Data on one particular size of thread is given on one page with corresponding NC and NF data on facing page.—AVIATION, Mar., '45.

Malleable Iron Handbook.....5

Being mailed to a limited list is bulletin from Malleable Founders' Society, Cleveland, titled *American Malleable Iron: A Handbook* in which chapters on casting design, pattern design, and machining practice are included. Physical, mechanical, and engineering properties are set forth as well as metallurgy of malleable iron, and a large section is devoted to engineering tables and data.—AVIATION, Mar., '45.

Resin Glue.....6

History of glue, development of waterproof resin types and methods of using them, and a wide range of present-day applications are described in booklet issued by Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo.—AVIATION, Mar., '45.

X-Ray Diffraction.....7

Diagrams, typical diffraction films and tabulations to illustrate techniques and applications of x ray diffraction apparatus in identification, comparison, and analysis of materials are contained in booklet from North American Philips Co., New York City.—AVIATION, Mar., '45.

Flexible Shaft Handbook.....8

Engineering data on flexible shafts and their application is topic of handbook issued by S. S. White Dental Mfg. Co., New York City.—AVIATION, Mar., '45.

Aviation Lubrication Manual.....9

Stating that margin between success and failure of lubrication has narrowed with each advance in engine design Shell Oil Co., New York City, lists basic developments as direct influences in No. 8 in series of booklets, *Panorama of Lubrication*. Specific problems that engine improvements have posed for oil industry are covered.—AVIATION, Mar., '45.

Tracefor Paper.....15

Described in booklet from Eastman Kodak Co., Rochester, N. Y., is "Linagraph" transfer paper, designed to permit lamination of paper's emulsion surface to metal and other materials. Paper is used in photocopying on templates and in photographic reproduction of instrument dials and name and instruction plates.—AVIATION, Mar., '45.

Beryllium-Copper Castings.....11

Physical properties of some beryllium-copper alloys, recommendations on heat treatment and machining practice and description of parts made of this material are contained in catalog from Beryllium Corp. of Penn., Reading, Penn.—AVIATION, Mar., '45.

Industrial Rubber.....12

Booklet from B. F. Goodrich Co., Akron, reproduces 25 advertisements on industrial rubber products, including hydraulic hose for aircraft.—AVIATION, Mar., '45.

Electric Welded Tubing.....13

Written for designers, new booklet from Formed Steel Tube Institute, Cleveland, contains specifications for various applications, characteristics of electric welded tubing, and other information.—AVIATION, Mar., '45.

Cellulosic Thermoplastics.....14

Hercules Powder Co., Wilmington, Del., offers technical booklet listing and describing results of dimensional stability tests on cellulosic plastics at high temperatures and humidities.—AVIATION, Mar., '45.

Sound Control.....15

Development of methods and material used in aircraft teal-call soundproofing is topic of booklet from Industrial Sound Control Div., The Homestead Corp., Hartford County. Description and characteristics of "Soundstone" are given.—AVIATION, Mar., '45.

PRODUCTION

Wire Rope.....16

Lubrication, maintenance, splicing, and various applications are among subjects covered in bulletins from Macwhyte Wire Rope Co., Kenosha, Wis.—AVIATION, Mar., '45.

Direction Indicator.....17

Offering simplified navigation for the pilot, new direction indicator, or direct indicating vertical dial compass, manufactured by Kollsman Instrument Div., Square D Co., Elmhurst, N. Y., is described in folder.—AVIATION, Mar., '45.

Scrap Prevention.....18

Illustration of savings through salvage of defective castings by use of "Ampco-Trode" weld rod is contained in Bulletin No. 129 from Ampco Metal, Inc., Milwaukee.—AVIATION, Mar., '45.

Aircraft Flow Meter.....19

Among features in new remote-reading flow meter manufactured by Fischer & Porter Co., Hatboro, Pa., and described in circular, is new electrical circuit, with transmission to remote indicator completely electrical. Details of additional features are covered.—AVIATION, Mar., '45.

AVIATION READER'S SERVICE

AVIATION, 330 W. 42nd St., New York City 18

MARCH 1945

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Cowl Fasteners.....20

Installation procedure in use of cowl fasteners, Series 4000, is topic of Booklet No 44 B, issued by Camloc Fastener Co., New York City. Illustrations are included—AVIATION, Mar., '45

Brazing Carbide Tips.....21

Procedure in brazing high speed steel and carbide tool tips with "Easi-Flow" No 3 silver brazing alloy, is given in Bulletin No. 11-A from Handy & Harman New York City. Stressed is low working temperature and free-flowing properties.—AVIATION, Mar., '45

Lead Screw.....22

Ball bearing screw and nut assembly manufactured by Saginaw Steering Gear Div., General Motors Corp., Saginaw, Mich. is described in booklet. Various aircraft applications are listed.—AVIATION Mar., '45.

Aircraft Seats.....23

Bulletin No. 5 from Warren McArthur Corp. New York City, illustrates many types of plane seats made by company.—AVIATION, Mar., '45

Silver Soldering Flux.....24

An alkaline non-corrosive non-fuming flux for silver soldering, No. 0, made by Superior Flux Co., Cleveland, is described in bulletin.—AVIATION, Mar., '45.

MACHINERY & ACCESSORIES

Air in Production.....25

Illustrating many applications employing air pressure in various shops, booklet titled *A Little Air Power Will Do Many a Big Job*, issued by Ingersoll-Rand Co., Phillipsburg, N. J., is clearing house of ideas for production men — AVIATION, Mar., '45.

Flat Surface Finishing.....26

Third edition of booklet, *Work Done On the Blanchard*, is offered by Blanchard Machine Co., Cambridge, Mass. It illustrates and describes many standard and special uses to which grinders are put in flat surface machining and finishing.—AVIATION, Mar., '45.

Hot-Dip Tanks.....

New hot-dip tank for aircraft parts cleaning, Model 40RT, is announced by Aerol Burner Co., West New York, N. J. Completely insulated and heated from inside, tank has capacity of 1100 gal. Its dipping space 40 in. long, 32 in. wide and 10½ in. deep—AVIATION, Mar., '45

Wet Belt Surfacer.....

Described in circular is new wet belt surfacer with automatic feed table, Model BGS-8, made by Porter-Cable Machine Co., Syracuse, to which hydraulic system and mechanical settings control speed, pressure, finish, and size.—AVIATION, Mar., '45.

Materials Handling.....

Containing special sections on lift trucks, skid platforms, power fork trucks, stackers, cranes, float trucks, and storage racks, new catalog has been issued by Lewis-Shepard Co., Watertown, Mass.—AVIATION, Mar., '45

Eaglen Pre-Oiler.....

Designed to eliminate carbonization and "spot cracking" of lubricating oil, an engine pre-oiler manufactured by Dunham Aircraft Service, Flushing, N. Y., is described.—AVIATION, Mar., '45

Master Gage Blocks.....

Information is available on master metric gage blocks, set No. 110, designed for producing any combination of sizes required to precision measuring.—Matched in Continental Machines, Inc., Minneapolis.—AVIATION, Mar., '45.

Dial Indicators.....

Gages and dial indicators for internal measuring, size control, and gaging testing is illustrated and described in catalog No. 03 from B. C. Ames Co., Waltham, Mass. New models include long range indicators, portable dial micrometers, No. 1325 comparator and new developments in dial test indicator parts.—AVIATION, Mar., '45.

Surface Roughness Measurers.....

The "Profiler", instrument for measuring surface roughness made by Physicists Research Co., Ann Arbor, Mich., is described in new catalog which contains information on nature of surface roughness, also description of how instrument and its accessories operate.—AVIATION, Mar., '45

Scaffolding and Towers.....

Line of tubular steel welded scaffolding, ladders and towers is described in new catalog from Universal Fittings and Scaffolding Co., Zelienople, (Pittsburgh district), Pa. Photographs of new installations are included.—AVIATION, Mar.

Resistance Welding Equipment.....

Including chart giving proper electrodes for spot welding similar and dissimilar metals, table of equivalent ratings, list of transformer temperature rise, and definitions and quality of resistance welding equipment, new booklet has been issued by Resistance Welder Mfrs. Assn., Philadelphia.—AVIATION, Mar., '45.

Die Casting.....

Lester-Phoenix, Inc., Cleveland, O., booklet descriptive of line of die casting machines and contains information on pre-fill injection system for cold chamber die casting.—AVIATION, Mar., '45.

Maintenance and Salvage.....

Bulletin No. 200 from Aircraft Service Products Co., Long Island City, N. Y., describes maintenance and salvage operations in aircraft shops using "Hel-Coil" bushings.—AVIATION, Mar., '45.

Leather Belting Manual.....

Leather belting manual offered by Graton & Knight Co., Worcester, Mass., contains data, charts, and specifications designed to provide non-technical help in selection, application, costs, and care of various types of leather belts.—AVIATION, Mar., '45

Baby Saw for Metal.....39

Pneumatic baby saw 9 in. long and weighing 2¾ lb., designed for sawing metal sheet to 3/16 in. thick, is described in bulletin No. 90S from Cleveland Pneumatic Tool Co., Cleveland Ohio.—AVIATION Mar., '45.

Multiple V-Belt Drive.....40

Graphic presentation of features of multiple V-belt drive is contained in booklet titled *10 Reasons* from Multiple V-Belt Drive Assn., Chicago —AVIATION, Mar.

Inspection Height Gage.....41

Information on use of height gage in inspecting and laying out work is contained in circular from F. & H. Mfg. Co., Detroit.—AVIATION, Mar., '45.

Straightening Presses.....42

Bulletin No. VJ-44 from Colonial Broach Co., Detroit, describes line of hydraulic straightening presses, listing standard and extra equipment and giving specifications on models ranging from 10-50 ton cap.—AVIATION, Mar., '45

Light Duty Lathe.....43

Divine Bros. Co., Utica, N. Y., has developed small lathe for light polishing, buffing and deburring of small parts, called "VJ" it is V-belt driven, with motor sizes up to 3 hp. and with spindle speed ranging up to 3,950 rpm. Circular gives description.—AVIATION, Mar., '45

Degreasing Spray Gun.....44

Circular from DeVilbiss Co., Toledo, describes new pressure feed spray gun designed for degreasing and cleaning operations on castings, forgings, and sheet metal.—AVIATION, Mar., '45

Central Coolant System.....48

Clean Oil is title of booklet describing grinding, cutting, boring, and honing operations by means of central system. Both stationary and mobile purification equipment is shown. Maker is Oliver-Cranz Corp., subsidiary of Hounaille-Hershey Corp., Lebonon, Ind.—AVIATION, Mar., '45.

Carbon Removal.....46

Turco Products, Los Angeles has developed new supplementary treatment to chemical processes now in use for removing carbon from aircraft engines. Called "Carbonlift", full information on treatment is available.—AVIATION Mar., '45

V-Belt Drive Catalog.....47

Charts, tables, and drawings simplify correct v-belt drive selections are contained in catalog from Allis-Chalmers Mfg. Co., Milwaukee.—AVIATION, Mar., '45

ELECTRICAL

Electric Generating Plants.....48

Folder No. 99E from D. W. Onan & Sons, Minneapolis, describes compact, single-unit electric generating plants in capacities from 95W to 60,000 for emergency, auxiliary, or standby service.—AVIATION, Mar., '45.

Quick Disconnect Terminals.....49

Typical procedures in use of "Sta-Kon" straight pull disconnect are illustrated in folder circular from Thomas Batta Co., Elizabeth, N. J.—AVIATION, Mar., '45.

MANAGEMENT & EMPLOYEES

Fire Extinguishers.....50

Construction specifications and underwriters laboratories classifications of seven basic types of fire extinguishers are given in folder, Your *Fire Protection Insurance Policy* from General Detroit Corp., Detroit.—AVIATION, Mar., '45.

Computing Tax Deductions.....51

Systems Div., Remington Rand, Buffalo, announces "Deductax", a device for speedy accurate computation of 1945 withholding tax deductions. Listed are 30 sets of figures in each of the weekly, semi-monthly and monthly charts.—AVIATION Mar., '45

Eye and Face Protectors

Catalog from Sellstrom Mfg. Co., Chicago, describes goggles, helmets, respirators, lenses, and safety shields for men and women, and for industrial and station uses.—AVIATION, Mar., '45

Welding and Cutting

Presented as step-by-step procedure and covering basic techniques of oxy-acetylene welding and cutting, series of slide films and accompanying instruction literature is offered by Linde Air Products Co., Division Union Carbide & Carbon Corp., New York City—AVIATION, Mar., '45.

AIRPORTS

Electrical Equipment

Catalog from Mines Equipment Co., St. Louis, describes applications of company connectors and various assemblies of receptacles and cable for battery charging and for battery cart connections as used by aircraft builders. Company has also developed a ramp receptacle to be located on runway for power takeoff from low power lines.—AVIATION, Mar., '45.

Refueling Methods

New system of refueling aircraft is described in booklet, *For the Airliner of Tomorrow*, issued by Wayne Pump Co., Fort Wayne, Ind. Speed of operation is stated to be feature.—AVIATION, Mar., '45

Profitable Small Airports

Sales of aircraft as major source of income for small airports is advocated in booklet from Aeronca Aircraft Corp., Middletown, Ohio, titled *How To Make Small Airports Pay With Aeronca*. Various types of company's aircraft are described and specifications given.—AVIATION, Mar., '45

Hangar Doors

Byrne Doors, Inc., Detroit, has issued folder descriptiva of line of standard and custom-built doors and hangers.—AVIATION, Mar., 45.

Parts for Airport Buildings

Metal roofing and siding, hangar doors, structural sub-flooring, metal panels, decking, partitions, and other units are described in booklet from H. H. Robertson Co., Pittsburgh.—AVIATION, Mar., '45.

Dealer Franchise

The Scott Chartered Dealer, booklet from Scott Aviation Co., Lancaster, N. Y., describes procedure for planning of private airport operator's program and outlines merchandising plans.—AVIATION, Mar., '45.

Airport Insurance

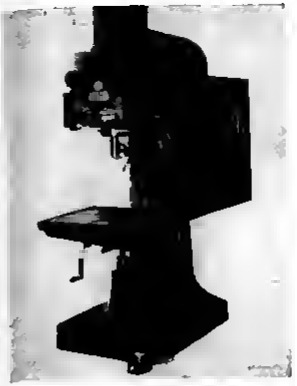
Details of special policy covering airport liability insurance are given in circular from Aero Insurance Underwriters, New York City.—AVIATION, Mar., '45

NEW PRODUCTS

Latest Machine Tools

Tapping-Threading Machine

Developed by **Cleveland Tapping Machine Co.** for maker of aircraft parts, tapping and threading machine is lead-screw controlled at all times, yet is reported to have rapid approach and retraction of spindle. Lead-screw assembly, slides on scraped ways, has specially designed locking devices, and is never disengaged from spindle. Two air cylinders control approach and retraction of spindle but exert pressure when tapping. Approach can be set to stop within .010 in. of hole. Pull is removed at twice tapping speed. Reversing mechanism is mounted on drive shaft and is actuated by two opposed bi-metallic clotches, one operating tapping cycle, the other the reverse



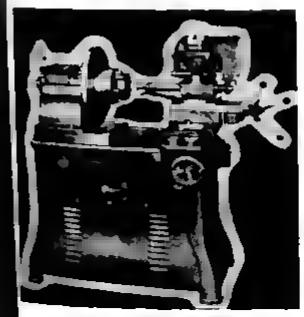
cycle. Vertical travel of spindle is stated to be controlled to within .005 in. limits and rotation of spindle held to ½ revolution. Speed ranges are from 40 to 400 rpm. with higher ranges available. Motor does not reverse. Tapping capacity is from ⅜ in. to 1 in. in steel. Two dial sheets graduated in thousandths, control rapid traverse and depth stop. Controls can be set to permit rapid approach up to 5 in. and tap 1 in. or rapid approach 1 in. and tap up to 5 in. Gage regulates pressure on clutch. Speed indicator and stop button are conveniently placed. Machine is operated manually or automatically.—AVIATION, Mar., '45.

Brazing Furnace 62

Designed for silver brazing at low temperatures, copper brazing at high temperatures, powder metallurgy, bright annealing, general tool hardening, and high speed tool hardening, new furnace made by **Lindberg Engineering Co.**, Chicago, is flexible because of its wide range of working temperatures—from 1,000 to 2,500 deg F.—AVIATION, Mar., '45

Internal and Surface Grinder 63

Designed for turning and grinding internal, external, face, and taper jobs new grinder developed by **Lempco Products Co.**, Bedford, Ohio, has micrometer screw adjustment on automatic power cross-feed and both rack and pinion and screw feed are available for longitudinal travel. Jaw or magnetic chucks are mounted on face plate by single draw bar through hollow work spindle. Work speeds range from 30 to 130 rpm., and spindle speeds from 6,000 to 12,000 rpm. Machine has 2 hp. grinding head motor and ½ hp. workhead motor, both self-contained. Workhead is retractable. Automatic eizer mechanically duplicates size of successive pieces.—AVIATION, Mar., '45.



Shop Equipment & Materials

Gear Tooth Checker 64

National Broach & Mechine Co., Detroit, has developed device for checking eccentricity and tooth parallelism of spur gears. Made in sizes for max. pitch dia. up to 12, 18, or 24 in., and in special bed lengths for gears with integral shafts, device consists of rigid base with flat top and having two "V" keyways crossing at 90 deg., one for adjustable work holding centers and other for checking heads, one on either side of work gear. Eccentricity head has spring-loaded retractable spindle with interchangeable conical contact point to suit pitch and pressure angle of gears. Rear of

spindle carries arm which contacts and actuates spindle of dial indicator on top of head, which is so set that contacting point engages gear either at pitch line or at root under spring pressure and indicator is brought to zero. Then by retracting spindle and indexing gear, indicator readings are taken, and any change from zero represents eccentricity — total between high and low. When contact finger is engaged with tooth at one end and indicator set at zero, any variation in reading as finger is moved represents error in parallelism. Latter head may be used to check amount and position of crown on elliptoid teeth.—**AVIATION, Mar., '45.**

Non-Ferrous Indicator 66

Designed especially for use in an active magnetic field, new non-ferrous pedestal indicator, manufactured by **Bethel Engineering Co., Beloit, Wis.,** is constructed of hard brass, making it suitable for setting up and checking work which is held in magnetic chuck. Model **UNF-10** is designed for gaging from flat surfaces. For approximate setting, carriage block is changed on upright. Dial indicator is adjusted to exact position on face of carriage block with micrometer screw and clamped separately thus stated to permit added closeness of vernier adjustment. Dial has a first division reading of .0001. Over all height is 9 in. with range of approx. 4 in. from base surface upward.—**AVIATION Mar., '45.**

Inspecting Moving Objects 68

Communication Measurements Laboratory, New York City, announces new Model 1200 Stroboscope, which is described as capable of stopping for study rotary speeds from 600 to 600,000, or vibrations from 10 to 10,000. Light source is mounted in small probe at end of 5 ft. flexible cable so that small objects may be viewed to close range. Instrument may be operated from external tuning fork or crystal standards. Pulses are derived from stable audio oscillator for accuracy of repetitive pulse rate. Light intensity control switch is provided to control intensity of light and duration of pulse length.—**AVIATION, Mar., '45.**

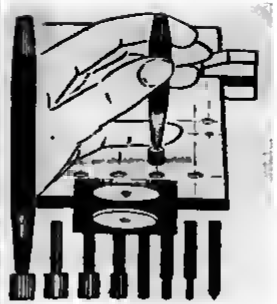
Binocular Magnifiers 67

Developed to serve for inspection work where the field to be scanned at one time is large, Model C "Magni-Ray", manufactured by **George Scheer Co., New York City,** has 5 in. lens made of high grade optical glass. Instrument is encased in aluminum alloy casting with handle for transporting instrument to work or for

fastening to machine tool to observe turning or grinding operations. Housing is fitted to 10 in. upright rod with universal clamping device, which permits swiveling four ways. Device is designed for detection of cracks, imperfections and blowholes in large castings, is also useful in assembling small and delicate mechanisms, and for inspection of ground, polished, or lapped surfaces.—**AVIATION, Mar., '45.**

Reversing Height Gage 68

New head for "Electramirit" height gage, made by **Pratt & Whitney, Div. of Niles-Bement-Pond Co., Hartford, Conn.,** is fitted with small lever by means of which gage may be set for measuring either up or down. Gage is offered complete with indicator and either of two stands, or head can be purchased separately. New reversing gage operates on principle of translation of a mechanical movement into electrical magnification stated to produce very sensitive results on precision work.—**AVIATION, Mar.,**



Chaplate Traceter Pouches 69

Advantages of template transfer pouches made by **H. D. Allen**, Los Angeles, are described as follows. Points are uniformly concentric with bodies and adjustable to size within .0004 in. punches, used with universal holder, are traction at head and weight of solid punches, also under takes scriber and prick punch, and cannot roll. Mark made by punches is used to insure correct guide for layout tools as well as for center drills and punch pilots. Punches are used also for panel layouts locating instrument pivot holes, aligning plates for drilling and tapping, locating dowel pins and screws in die sets, tap drill locating from body size holes transferring station and center marks from parts to fixtures and jigs, and locating and refitting replacement parts available from stock are: (1) Punches for light gage templates made in 29 standard dia. from .040 to .375 in. with points .250 in. high and one holder serving all punches (2) heavy duty punches made in assorted dia. from ⅛ to ½ in. and having universal holder with points several times larger than those of punches for light work, and (3) solid type punches made in 7 sizes from ⅛ to ⅝ in. Special sizes and types may be ordered.—**AVIATION, Mar., '45.**

Spring Plungers.....70

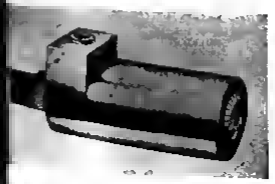
Vlier Mfg. Co., Los Angeles, has produced coil spring plungers used as tool- and locating pins breaking oil seal on and holding parts against permanent which are described as having uniform pressure and free plunger action. Plunger completely telescoping within body. Plungers are available in sizes ⅛ x 5/32 x 16, and ¼ x 20 lb., with ¼, ⅜, and 15 in. ends.—**AVIATION, Mar., '45**

Power Cutting Brush.....71

Described as extending application of wire brushes to work hitherto considered impractical, new power brush for removing burrs, preparing metal surfaces, cleaning rubber parts and many other applications has been developed by **Osborn Mfg. Co.**, Cleveland. Called Monitor brush No. 1469-S-23. It is a 12-in. section filled with 60-in. power brush wire, and there are 45 ⅜-in. arbor holes.—**AVIATION, Mar., '45.**

Boring Bar Insert.....72

Designed to permit use of pieces of carbide tool bits as replacement cutters, micrometer-adjustable boring bar insert has been developed by **Nash-Zemple Tool Div., J. M. Nash Co.**, Milwaukee. Procedure is to square up cutter stock to fit square hole in insert, which is done on surface grinder without use of special tools. Insert can be installed on any bar by simple boring operation. Locating-head of insert fits snugly into recessed slot or bar, set screw in bar locates insert and draws head against shoulder of slot. Micrometer dial has 25 graduations of .0001 in. each. Insert is made in 46 standard sizes and can be made in special sizes. Standard or special bars can also be furnished.—**AVIATION, Mar., '45.**



Electric Hoist.....73

Built to big hoist specifications new ¼ ton model, made by **American Engineering Co.**, Philadelphia, has heavy duty ⅝ hp hoist and crane type motor with high starting torque heavy duty spur gear, and heavy duty Weston screw and disk type automatic lowering brake. Bolt suspension type hoist weighs 195 lb and plain trolley type weighs 225 lb.—**AVIATION, Mar., '45.**

Tool Tips.....74

New line of tool tips made of "Hardsteel" and designed for brazing into steel shanks is announced by **Black Drill Co., Div., Black Industries**, Cleveland. Reported capable of being readily reground and easy to braze, they are stated to permit making of tools that combine strong shanks with high abrasion and shock resisting qualities.—**AVIATION, Mar., '45.**

Sealed Ball Bearing.....75

Plas-Seal", new type sealed ball bearing, is announced by **Fafnir Bearing Co.**, New Britain, Conn. Sealing element consists of diaphragm type contact seal comprising a flat, flexible sealing washer of synthetic rubber-impregnated fabric, and there is a split retaining ring of spring steel. Bearings except in very small sizes are held to same width as standard unsealed bearings. Sealing washer does not rotate with inner ring but is in contact with a ground groove to form seal.—**AVIATION, Mar., '45.**

Narrow Lever Key 76

Its 18-spring capacity designed to permit over 500 possible switching combinations, narrow lever key is in wide use in open and enclosed panels for electronic and communications equipment, by Federal Telephone & Radio Corp., Newark, N. J. Is held together by single screw. Device operates one- or two-way locking or nonlocking, and the spring pile-up mounts on one side of two-piece pressed steel frame with all front position springs in one group and all back position springs in another. Non-click buffer springs are supplied where backlash is to be avoided, and key can be furnished with momentary-contact when desired.—AVIATION, Mar., '45.

Magneto Test Stand 77

Single control to permit quick speed changes—with armature control automatically switching to field control after base speed is reached—is stated to be feature of new Model PA 905 magneto test stand developed by Airplane Mfg. & Supply Corp., North Hollywood, Calif. Stand is designed to drive dual distributors with magneto Flange mounting magnetos with integral distributors may be mounted and tested at required speeds. Magneto is directly driven and distributors driven and geared from main drive. Motor is 5½ constant hp. unit with speed range of 0 to 3,700 rpm. Power is supplied from built-in unit. Standard external power is 440 a.c., 3-phase, 60 cycle. Electric tachometer is 0 to 3,000 rpm and d.c. ammeter is 5 to 25 amps. Adjustable gap panel is 30 pole. Unit is 40 in. long, 20 in. high, and 30 in. deep and weight is 300 lb.—AVIATION, Mar., '45

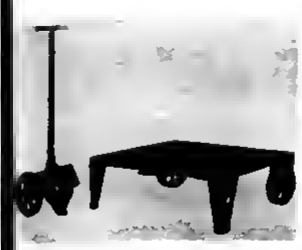
Protected Type Motor 78

Rated 40° C rise, full-load continuous duty, with a 15 percent service factor, protected type motors developed by Crocker-Wheeler Div., Joshua Hendy Iron Works, Ampere, N. J., are available in

sizes up to and including the 254 frame. There are no openings in frame or shield above horizontal center line and ventilating openings are shielded.—AVIATION, Mar., '45.

Sequence Timer 79

New weld and sequence timer known as type CR7500-F170 and made by General Electric Co., Schenectady, is designed providing various time and current adjustments necessary for welding heavy sections of air-hardenable steels. It may be used in combination with most of company's spot-welding controls which include phase-shift method of heat control. Operating from 230/460/575v. 60 cycle control adjusts time of current flow and its magnitude for preheating, weld grain refinement, and tempering. Other adjustments control time for chilling of weld nugget, following weld and grain refinement periods. Control consists of seven time intervals, seven independent heat adjusters, two pressure intervals, and one squeeze timer, and provisions for two-stage foot switch.—AVIATION, Mar., '45



Floor Plate 80

New use for 24-way non-skid floor plate is in its application to standard transport chassis made by Factory Service Co., Milwaukee, maker of Turnar system of materials handling. Floor plate (see cut) is welded flush with top of chassis side frame angles and is reinforced by two heavy angles on under side. Embossments provide point contact with heat materials to eliminate warping of steel deck and to prevent metal parts from slipping.—AVIATION, Mar., '45

Abrasives 81

Described as an improvement in coated abrasives "Durabonding" treatment developed by Behr-Manning Div., Norton Co., Troy, N. Y., is stated to harden adhesive and makes it more resistant to heat and less sensitive to humidity. Material used in construction of abrasive belts, fiber combination disks, and cloth products.—AVIATION, Mar., '45

Steel-Roughing Tools 82

Tools ranging from ⅜ to ¾ in. employing grade 78C cemented carbide and designed for steel roughing work, have been added by Carmalov Co., Detroit. Tools are available in five styles, and line consists of 1 straight turning, L.H. straight turning, R.H. and 45 L.H. 15-deg angle facing, and square nose tools.—AVIATION, Mar., '45.

Boring Bar 83

Designed for use without bushings or collars and stated to require no clamped holders, new lever-lock boring bars manufactured by Rabt. H. Clark Co., Beverly Hills, Calif., are available in sets of four, ⅜ x 8 in., ½ x 8 in., ⅝ x 7 in., and ¾ x 8 inch. Carbide bits in sizes for use with these bars are available. One high speed threading bit and one boring bar are provided with bar. Lever-lock holds tool bit at right angle on one end and 15 deg angle on other end. Replacement cutters are readily made from round carbon or high speed steel drill rod.—AVIATION, Mar., '45.

Rubber 84

Hewitt Rubber Corp., Buffalo, announces entrance into field of foam rubber manufacture, postwar. New product is called "Restfoam" and is projected for use in luxury aircraft of the future.—AVIATION, Mar., '45.

Electrical Appliances

Terminal Block 85

Described as capable of withstanding 2,000 a.c. insulation breakdown test, ceramic terminal block developed by The Henry Co., Los Angeles, is designed to eliminate screws through use of cam-type bridge element which bears against wire or terminals to be connected. Self-locking feature provides for snap-in connections requiring manual release with levers for identification markers. No junction boxes are required.—AVIATION, Mar., '45.

Snap-Action Relay 85

Type 79NAX relay made by Struthers-Dunn, Inc., Philadelphia, has been redesigned to meet need for sensitive, easily adjustable snap-action relays, maker states. Design is described as assuring full normally closed and open contact pressures, eliminating erratic operations and varying contact resistance. Armature almost completes it travel in either direction before contacts snap into new position, which permits use in making an unusually broad range of applications including vacuum tube circuits, overcurrent protection and pulsing circuits. Standard adjustments using 60 nine turns in coil at approx. 92 w., results in contact pressures of 5 grams with contacts rated at 5 amp. 115v. a.c. or 0.5 amp. 115v. d.c., noninductive. Contact ratings up to 10 amp. 115v. a.c. may be obtained with 100 or more amp. turns and corresponding increase in power. Sensitivity of 0.005 w with 30 amp. turns is obtainable with reduced contact ratings and pressures according to statement issued by manufacturer.—AVIATION, Mar. '45.

Signal Generator 87

Described as meeting broad requirements of today's testing signal generator No. 704, made by Radio City Products Co., New York City, has range from 95 kc to 100 mc. Fundamental frequencies are continuously variable from 95 kc to 32 mc in 5 bands. Calibration is stated to be accurate to 2 percent per band up to broadcast band and within 3 percent for high frequency bands. Model 704 has planetary drive condenser with direct reading calibration, and output can be modulated or unmodulated. Self-contained modulation is either 400-cyc. or 1,000-cycle sine wave which modulates carrier. Either is available for external use.—AVIATION, Mar., '45.

Sparkplug Gap Setter.....88

Setting two guns at once on Aero, BG Bendix and Champion plugs, sparkplug gap setting machine made by **Ourham Aircraft Service.**, Flushing, N. Y., is stated to feature speed and accuracy. After machine is set for gapping of particular type plug, it will gap thousands, states maker, and only maintenance necessary is changing of feeler gages due to wear.—**AVIATION, Mar.**—'45.

Fuel Transfer Pump 89

Romec Pump Co., Elyria, Ohio, has developed new non-pulsating fuel transfer pump for use on heavy aircraft. No. RD-4160 has rated cap. of 900 gph. at 27-in. hg. discharge pressure x 5 in. hg. inlet suction, 14.5 amp. max. Ports are tapped 1¼ to N.P.T. Combined with 24-v. motor and Sprague radio noise filter pump is designated Unit RD-4160. Motor is a reversible, continuous duty, shunt wound and explosion proof type, rated at ⅝ hp. at 2,500 rpm. and 24-v. d.c. Unit weighs 18 lb. 12 oz.—**AVIATION, Mar.**, '45.

Aircraft Parts & Accessories

Selector Valve.....90

Designed for remote-control aircraft installations such as bomb bay doors, new pneumatic solenoid selector valve for air gas, or hydraulic fluid up to 1,000 psi. max. pressure is announced by **Adel Precision Products Corp.**, Burbank, Calif. Valve measures 3⅝ x 3¼ x 6 in., including handle. Current of 1.2 amp. at momentary impulse automatically drops to holding pull of 0.6 amp. at 24-v. d.c. Ports provide for ⅝-in. line sizes. Shaft enables manual operation in emergency. Electrical connections are for either 1- or 2-wire and ground circuits and terminal posts have plastic caps.—**AVIATION, Mar.**—'45.

Flexible Tubing.....91

Rex-Flex stainless steel flexible tubing, made by **Chicago Metal Hose Co.**, Chicago, is now available in 6-in. size for aviation use. It is announced.—**AVIATION, Mar.**—'45.

Liquid Control 92

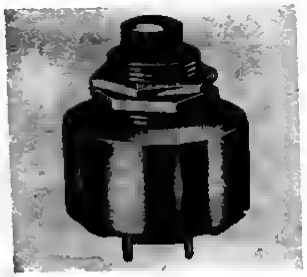
Designed for controlling flow of fuel, oil, gasoline and steam, new type rotary split-sleeve valve manufactured by **Clarke Aero Hydraulics Co.**, Pasadena, Calif., is stated to expand and contract to conformity to pressures and temperatures. Two-way model in ¾ in. size operates under pressures up to 1,000 lb. at temperatures from minus 65 deg. to plus 160 deg. F. Principles and features are adaptable to wide range of aircraft uses—straightaway, T, angle and fine shut-off valves, for example.—**AVIATION, Mar.**, '45.

Aircraft Temperature Regulator 93

Employing principle of temperature gap formed by two electrical contacts in a mercury thermostat which control individual relays, 'Modutemp' temperature regulating unit for oil coolers, coolant radiators, and heating systems of aircraft, has been developed by **Vapor Car Heating Co.**, Chicago. Contacts are set to meet temperature specifications and range of individual requirements. System may be specified to handle various sizes of motors. Where hydraulic or pneumatic power is used, unit controls through operation of solenoid valves.—**AVIATION, Mar.**, '45.

Nut Type Switch.....94

Acro Electric Co., Cleveland, has developed nut type switch with double break feature for panel mounting applications. Case is of cadmium plated brass with threaded sleeve ⅞-32, carrying two locknuts. Springs are of heat-treated beryllium and contacts silver. Switch is actuated with Bakelite plunger, and circuits are normally open or closed type. Rating is 15 amp. at 115 v. a.c. Dia. is 1⅛ in. Total air gap is .040-.060 in. Switch is made in two pressure ranges of 10-15 oz.



and 16-24 oz. Pretravel is approx. 1/16 in., overtravel 1/32 in.—**AVIATION, Mar.**, '45.

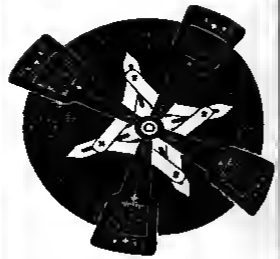
Hose Clamps .....

Aircraft Standard Parts Co., [illegible], Ill., is now producing "Aera Seal" clamps made of stainless steel in M12, M16, and M20, with all nominal [illegible]

from ½ through 4¼ in. to be a[illegible] later. Stated to be lighter and thinner, stronger and more flexible, new mechanically interlocked saddle is stated to eliminate welds.—AVIATION, Mar., '45.

Radio Range Orientator .....

Designed by A/C John R. Dean of [illegible] and further developed by Aviation Associates, Chicago, new type radio range orientator and turn and heading computer described as giving pilot instantly and accurately, his bisector heading, drift corrections, heading to fly to reach next beam leg when getting fade-out signal, headings to fly during turn around procedure on each beam leg, ship-to-station bearing, and station-to-ship bearing. [illegible] arms can be set to coincide with published beam bearings of particular radio range being flown, and four bisector headings are then automatically indicated. Turn and heading computer is an integral side. Incorporated is a rotable disk with index arrow and fans sets of figures to give readings.—AVIATION, Mar., '45.



Airport Drainage Pipe .....

Described as being able to withstand crushing strength of 28,000 lb per [illegible] length, Staminite skip-pipe for airport drainage, manufactured by Robinson Clay Products Co., Akron, is shown in accompanying illustration supporting wheel of B-24 bomber.—AVIATION, Mar., '45.

Hydraulic Selector Valve .....

Reported as showing pressure drop at only 11 psi at 3½ gpm., new type of hydraulic 4-way selector valve made by Pacific Div., Bendix Aviation Corp., N. Hollywood, Calif., is radical in design, has

plastic poppet valve elements, and has curved fluid passages which are said [illegible] weight is 0.80 lb. 'Altaire' valve AN-815-4 is available in ⅜ in. tube size and ½ and ¾ in. 4-way selector valves may also be had.—AVIATION, Mar., '45.

Cabin Blower Drive .....

Designed for cabin heater drive in Douglas A-26, hot having wide application possibilities, fractional hp. electric motor drive unit manufactured by Electrical Engineering & Mfg. Corp., Los An-

geles, is light weight continuous duty type ½ hp., fan-cooled 7,000 rpm. motor equipped with right angle gear box and drive shaft. Unit is for use in 28v. system.—AVIATION, Mar., '45.

Shallow-Depth Light .....

Over-all depth behind front of panel to end of insulation barrier of new indicating light is 1 in. Manufactured by H. R. Kirkland Co., Morristown, N. J., 'De Luxe' [illegible] Unit is for single bulb mounting in a 1⅛-in. dia. hole in panels up to ⅛ in. thick and is for 28v. service. Exposed holding rim is of hex nut type ⅞ in. thick.—AVIATION, Mar., '45.

New Lubricant .....

Blended with any good grade oil, Gibraltar oil concentrate made by Hood Refining Co., Greensburg, Pa., is stated to produce a lubricant which will not settle out and cannot be extracted by a filter. It is described as preventing formation of hard carbon and is also said to penetrate metal pores giving good lubrication when cylinders heat up.—AVIATION, Mar., '45.

Type Collet 152

Addition of cup-point lug which penetrates stock slightly, to serrated section of collet is stated to provide additional gripping power with less locking tension, new collect called "Super Grip", made by Sheffer Collet Co., Traverse City, Mich. Lugs are usually set 010 to .1 in above sections but can be adjusted or turned away completely without removing collet from machine —AVIATION, Mar., '45

Polishing Wheels 103

"Norflex" is trade name of new solid polishing wheels made by Norton Co., Worcester, Mass. Three types—cork reinforced fiber resinoid, and resilient rubber—meet special requirements of wide range of de-burring finishing and polishing operations. All types possess a relatively soft and flexible bond that imparts a cushion like action for removal of small amount of material. Fiber resinoid bond is stated to provide fast cutting action adapted to de-burring and polishing operations. Resilient rubber bond wheels are suitable for lower speeds, and cork resinoid bond may be used in precision polishing work in cylindrical, centerless surface and internal grinders —AVIATION, Mar.,

Testing Fixture 104

Built to mount readily an Clark or Wilson hardness testing machines, new testing fixture for Jominy hardenability tests has been developed by Precision Scientific Co., Chicago, in cooperation with T. Ferguson of Notre Dame University, consisting of heavy rigid base casting in-cluding screw and quick return mecha-nism, plug which supports fixture is hard-

ened and ground tool steel. It projects forward through base casting and forms surface against which diamond point moves against bar. Bronze half-nut is fastened to quick release lever engaging screw, screw being released when test bar reaches end of travel and carriage returned to starting position —AVIATION, Mar., '45.

Adjustable Counterbores 105

Precision Mechanical Laboratory, New York City, announces counterbores adjustable to .001 in. over ranges of approx. ½ in. Called "PML", counterbores can be set in either right or left hand. Adjustable feature permits resetting after many regrindings. Regrinding is done at end of cutting bit, on bench grinder, and any desired contour can be obtained. Bit can be removed from holder while an machine-counterbores with desired pilots are available to sizes from ¾ to 1 in., with either straight or tapered inter-changeable shanks. Steel, carbide tipped or alloy bits are available.—AVIATION, Mar., '45.

Piston Ring Inspector 106

Designed to automatically inspect trueness of periphery and width of gap, electronic piston ring inspector developed by Sheffield Corp., Dayton, Ohio, is described as eliminating human element. Procedure is to insert ring to be checked inside master ring which is placed on instrument table and rotated by power-driven roller. Gaging functions are performed by scanning beams of light directed onto photo-electric cells which energize electronic circuits to illuminate three signal lights. As ring revolves one beam strikes periphery of ring. Clearance between it and master ring will result from any out-of-roundness, light falls on cell, and red signal is actuated. Otherwise, green signal flashes at end of complete revolution, provided width of gap is correct, or yellow signal will show if gap is undersize. Beam is interrupted by mechanical shutter at time gap is passing this point. Second beam scans width of gap, and third beam energizes another cell which flashes red light if width of gap is oversize. Instrument can be adjusted for various sizes, gap widths, and tolerances. Inspection cycle is stated to be less than 4 sec per piece. —AVIATION, Mar., '45.

Carbide Broaches 107

Willey's Carbide Tool Co., Detroit, announces solid tungsten carbide broaches made of Willey's metal, in dia. 200 to 1 in. and moderate lengths —AVIATION, Mar., '45.

Clamped-On Tool Tips 108

For heavy duty machining tools having clamped-on and interchangeable Kennametal tips are available from Kennametal Inc., Latrobe, Pa. Tips have clamping shelf along top of side opposite cutting edge, diamond ground on under side. When dull, tip is advanced and reground a process which may be repeated many times. Tips are available in various grades, and tools in several styles and sizes.—AVIATION, Mar. '45.

Basic Research

(*Continued from page* 115)

If it is remembered that only a few years ago the design of an airfoil section was a relatively hit-or-miss proposition in which the eye of the designer played a major part. At the present time, airfoils are designed to suit almost any given set of conditions. Shapes can be derived to suit any desired distribution of the pressure over the surface of the wings. In short, the airfoil can be tailored to suit the purpose of the airplane

High-lift devices also have been studied, and the latest forms developed from these studies will be found on all types of present-day aircraft. Similarly, the best positions for taking in air at the leading edges of the wings has been investigated, this problem now being practically solved.

Stability and ease of control are essentials of a first-rate airplane That the deadly uncontrollable spin has been all but eliminated in modern aircraft designs can be attributed largely to the work of the Stability Research Division. Virtually every modern American airplane has been tested in one or another of the NACA spin tunnels to determine spinning characteristics and to improve controllability. Many an experimental model, which has shown a dangerous tendency to fall into tight spins, has undergone minor changes in its control surfaces as a result of these tunnel tests—to come out of the division's laboratory free of control bugs and safe. With the Air Forces now writing controllability and stability requirements into the specifications of new planes, the importance of this aspect of NACA research can hardly be exaggerated.

As planes grow in size the importance of their ease of control also increases. Without the improvements developed by NACA in this field some of the largest planes of today would be as clumsy and awkward as a truck horse. In the 7 x 10-ft. atmospheric wind tunnel, models of such planes, remotely controlled by a pilot, are put through a full variety of test maneuvers. Devices developed by NACA measure the force needed on the controls to bring the planes out of maneuvers or to put them into steep dives, sharp banks, or rapid climbs. If the controls are heavy, alterations are made in the tail surfaces or in the wing control surfaces until the latest plane will handle with surprising ease.

On a long transoceanic flight, when a pilot and co-pilot may share the controls for many hours, the ease of handling may be far more than a convenience—may spell the survival of the plane and its crew in areas of turbulent air. It may mean that the pilots will be sufficiently rested to meet the problems of landing on rough, recently built fields at their combat-area destination. Fairchild's new C-82 Packet cargo plane went through all of the division's tests.

In an endeavor to utilize the superlative performance that could be obtained from the new low-drag airfoils, the Structures Research Division devised a new method of riveting skin to the wing structure. Countersunk rivets were formed in the outer surface of the wing, and any small projections remaining were machined off. If the wing was then polished, the rivet head disappeared in the general finish of the wing.

This method of riveting not only made it possible to obtain an extremely smooth surface, but the resulting joint was extremely strong. When a section of a wing assembled with such riveting was compressed in a hydraulic testing machine until it began to buckle, the surface broke up into wrinkles, but not one of the countersunk-head rivets was exposed.

The method makes it possible for the aircraft designer striving for the ...

most in performance to obtain a degree of smoothness, in the surface of fuselage and wings, that has never been feasible before.

So novel are the problems encountered in this research that, as a rule, the available commercial instruments can be used directly only rarely, and it regularly becomes necessary to develop special equipment for the larger part of this work. As a result, the Structures Research Laboratory, which resembles a large hangar, is filled with novel and unusual types of testing equipment. Development and operation of each one would form a complete story.

NACA laboratories have in the past yielded such results, and today are yielding secret, but spectacular, new results, at low cost. As recently as 1937 the total staff, from research workers to maintenance personnel, was only 446. Although vastly expanded to meet war needs for speed and volume, operations are still highly efficient, undoubtedly paying for themselves many times over in increased performance of American planes.

In a recent report, the Committee summed up its wartime duties as follows:

"The events of the past year, during which the United Nations have assumed the offensive with the aid of vastly increased air power, have indicated more clearly than ever the necessity for continuous technical development of aircraft. The need for new and improved types of combat airplanes has been strikingly demonstrated by experience gained in the operation of our aircraft in all corners of the globe. The military necessity for meeting the best aircraft developed by the enemy and for building new types for the kind of warfare anticipated by the High Command has confronted American aeronautical engineers.

"In contact with the enemy in all parts of the world, new problems must be met by our flyers and, in turn, new requirements are imposed on the manufacturers. In some cases the new requirements cannot be met without extensive research and experimentation. Sometimes, improvements to correct defects in, or to increase the performance of, existing airplanes or equipment can quickly be found. At other times, a military requirement demands the search for an entirely new solution, unknown to the present art.

"More rarely, the discovery that enemy aircraft are in some features superior to American aircraft, demands urgent efforts to make up the deficiency. Research problems arise through the expressed needs of the armed services for improved performance, or in some cases out of the Committee's own experience and foresight.

again, as the result of unanticipated problems created by the enemy on the fighting fronts. All of these conditions, the committee's staff must be prepared to meet."

Leaders of the nation's aeronautical industry, military authorities, and others who have watched NACA's growth, emphasize that the task of the Committee will not end with the war. They say, in fact, that it may well play an even greater part in a postwar world in which American supremacy in the air may be essential to maintaining the peace.

Certainly, the future growth of the nation's air transport system will depend in no small degree on studies undertaken by the committee. Serving as an impartial advisor to all manufacturers, NACA will continue to be the research "midwife" at the birth of still better American planes.

Tomorrow's Avigation

(*Continued from page* 185)

with the tangential velocity of P^1 on the earth, occupied by the mass.

But a short time later, P^1 reaches the position q^1. The space direction of P^1 is changed. However, the force having kept its space east direction, has now a component which tends to move the mass not toward x^1 (earth's east) but to the left of this earth easterly course—to position K. To reach K, m moves from P^1 in the direction P^1m, which corresponds with q^1K, and m will continue to move to the left (towards the equator) until its linear velocity is equal to the tangential velocity of the earth. This movement to the left of the course due to the deflective force Co, is known as Coriolis effect.

The magnitude of the deflective force, Coriolis effect, is proportional to the angular velocity w, of the earth and to the speed, V, of the mass relative to the earth. This force is obtained from the direction of V by rotation through a right angle in a sense opposite to the earth's angular velocity.

At latitude l, where angular rotation $=w \sin l$, $a=2wV \sin l$.

Therefore, Coriolis effect$=f=2mwV \sin l$.

Coriolis force is a fictitious force which is apparent only with reference to the earth and its coordinates. From a fixed position in space all masses move in straight lines, unless acted upon by some external diverting force. But to an observer in the northern hemisphere, a mass moving in any direction subjected to no acceleration other than gravity, would describe a completely closed path as a result of the continued action to the right. (An ob-

server in the southern hemisphere would observe the mass moving to the left in a closed path).

It can be shown that this path is an approximate circle, known as inertia circle. The departure from a true circle becomes greatest near the equator. Since the apparent force depends upon the sine of the latitude, it has its maximum effect at the poles and does not exist at the equator. Also, as the equation for Coriolis effect indicates, the force is directly proportional to the mass and its horizontal velocity.

We are accustomed to regard velocities and forces as occurring upon fixed stationary surfaces. The vectors, under these conditions, are relatively simple quantities. But it has been shown that what is apparently a single velocity or force is actually, due to the shape and rotation of the earth a combination of velocities and forces. These concealed terrestrial properties are revealed only when proper frames of reference are selected for measuring the conditions. As has been noted, the earth is a gigantic gyroscope, and the phenomena of velocity and force instead of taking place upon a stationary plane, should be regarded as taking place upon a gyroscope of dimensions and speed appropriate to those of the earth.

It was demonstrated that a moving body, held to the earth by gravitational acceleration g, and trying to make good a course in the northern hemisphere, is always deflected to the right. Acceleration a, which produces this deflection, is at right angles to the course and also at right angles to gravity's acceleration, g. The angle formed by the vector resultant of g plus a and the vector g, measures the deflection. Since $a = 2\,w\,V \sin l$, the angle increases with V.

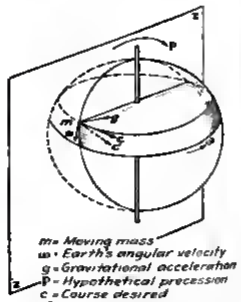


Fig. 6. Earth's gyroscopic effect on moving matt.

The deflective acceleration could be regarded as a function of the precessional effect of a gyroscope. If a plane be cut from the earth along the plane of a parallel north of *m*'s location and along the plane of a parallel south of the location, a gyroscope is created in which the N-S axis of the earth is the spin axis (Fig. 6). Let a plane z-z be passed through what would be the meridian of *m*'s location. The course of *m* can be represented by c (the W-E component of the course.) An equivalent to gravitational acceleration, *g*, acting toward the axis, is assumed to hold *m* on the gyroscope's surface.

Since *V*, the velocity of *m*, gives it a greater total velocity than the linear velocity of the earth, there is an acceleration and therefore a force and a couple acting in the direction c. The couple acts at right angles to the plane z-z and lies in the plane of *m*'s latitude. The couple acting on the gyroscope should cause it to precess in the direction P, in the plane z-z. But the magnitude of the couple is so small, compared to the gyroscope-earth, that no precession can occur. Instead then, the gyroscope can be said to resist precession. The direction of the resistance being opposite to the direction of precession it must lie in the plane z-z and be in the direction and amount determined by acceleration *a*. This is the deflective acceleration, known as Coriolis effect, and has the properties previously described. The mass *m*, responding to accelerations, tends to be forced away from the line of direction of precession, that is, to the right of c in the northern hemisphere. As a result, the course is deflected from c to c', and the greater the velocity the greater the deflection away from c.

The nature of the physical world is complicated and is manifested in subtle as well as awesome fashion. Euclidian geometry and Newtonian physics have been the principal instruments for studying the mysteries of space. They can no longer provide frames of reference for modern research or meet the postwar engineering demands.

Scientists have demonstrated the inaccuracy of a "straight line is the shortest distance between two points." Modern man, seeking to circumvent the temporalness by not only reducing space, but perhaps by condensing time, may relegate even great circle routes to mere historical significance as he supplants them with trajectories which consider nature's many forces.

What science may ultimately find are dimensions so vast, that human occupation with the task of encompassing them may redirect all those energies and lives, now given to winning today's limited space and materials, to the discovery of more inclusive systems of mensuration and values.

I-A for Fighting Eagles

"Push Pull" Breaker — one of the many types of Klixon Breakers used on all types of aircraft. Pull feature permits opening of circuit manually at breaker for de-energizing circuit for service work. Ratings of 5-50 amps. Other types available through 200 amps.

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There's hardly a plane that flies — bomber, fighter, trainer, transport — that isn't protected with Klixon Circuit Breakers. The reason for this widespread acceptance . . . complete, reliable electrical circuit protection no matter what the flying conditions.

Compact, lightweight, Klixon Breakers promptly trip-out the circuit should a short or a sustained overload endanger the electrical system. Once the trouble is remedied, the pilot re-establishes the circuit by merely pushing a button or snapping a switch. Klixon Circuit Breakers withstand shorts, vibration, [illegible] and altitude regardless of the position of mo[illegible] And although they are extremely sensitive to [illegible] loads, they're unaffected by harmless m[illegible] overloads.

Klixon Aircraft Circuit Breakers are available in [illegible] types . . . switch, push-pull, indicating, remote [illegible] trol, automatic reset and others. Write for b[illegible] containing sizes, weights, dimensions and p[illegible] ance characteristics.

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[illegible]NS of the "Par-Ka-Scope" is the eagle eye of a Parker-Kalon Assembly Engineer. He can help you focus on the [illegible]stening bugs" that usually hide out until you are all [illegible]t up for production, then start running up costs.

[illegible]E "BUGS" may be needless tapping, slow bolt-and-nut [illegible]ld[illegible], costly inserts in plastics that slow up molding, [illegible]eting in hard-to-reach places. Whatever they are, he'll [illegible]p you find them now, when a changeover to the [illegible]ort-cut fastening method . . . with P-K Self-tapping Screws . . . requires only a little pencil work.

SAVINGS OF 30% to 50% are the common experience of thousands of manufacturers who have adopted this *short cut method of assembling metals or plastics.*

THE P-K ASSEMBLY ENGINEER'S advice is unbiased. He'll recommend only the best Self-tapping Screw for the job — Parker-Kalon makes *all* types. Tell us when you'd like him to call, or send details of fastening jobs for recommendations.

THIS MANUFACTURER FOUND A MILLION "TAPPING BUGS"... FIND YOURS NOW!

By switching to P-K Type "U" Drive Screws in assembly of Hexacon Soldering Irons, the Hexacon Electric Co., Roselle, N. J., eliminated a million tapping operations a year formerly needed for machine screws. Time saving is more than 25%. Fastening is better, stronger than when machine screws (and before that, taper pins) were used.

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The P-K "Users' Guide" describes all types of Parker-Kalon Self-tapping Screws, and tells where and how to use them. Arranged so you can find the facts you need quickly. Write for it. Parker-Kalon Corp., 208 Varick St., New York 14, N. Y.

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Quality-Controlled
SELF-TAPPING SCREWS

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Pan American Uses Tenite To Blast Carbo From Pistons

GRANULATIONS of Tenite are used by Pan American World Airways to blast carbon from pistons. Blown at high pressure in sand-blasting equipment, the pellets knock carbon from piston sides and ring grooves and give the metal a polish without abrasion.

By the addition of Tenite pellets to the clover seed, wheat, or cracked corn particles previously used alone, blasting time may be cut in half. The grain particles absorb the oily smudge from the pellets and, when reduced to a flour, pass out of the exhaust. Tenite, by virtue of its extreme toughness, does not become pulverized from the force of blasting; and only four to five ounces of Tenite pellets in a charge are consumed per blasting hour.

Except that they are smaller, the pellets resemble those supplied to the industry for the molding and extrusion of many nationally known products. Information on Tenite and its uses may be obtained by writing to the

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(*Subsidiary of Eastman Kodak Company*)
KINGSPORT, TENNESSEE

TENITE *an Eastman Fl*

The Tale of a SHIRT with WINGS

The outstanding service of Reeves Army Twill in wartime is dramatically told in the diary of a shirt which belonged to an officer of the Army Air Force. This story speaks volumes for Reeves Army Twill for the shirt which is three years old has seen the world, and still makes a presentable appearance after having been laundered over fifty times under all kinds of adverse conditions.

- *It spent the summer of 1942 in Washington, D. C. where it was laundered many times at regular commercial laundries.*
- *In March 1943 it went to Tripolitania where it was washed by Arabs.*
- *In Sfax and Sousse, Tunisia, it was laundered by French and Italian women.*
- *February 1944 saw this shirt on board a British Troop Transport in the Mediterranean where it was washed by Indian bearers.*
- *It spent two weeks in Cairo, traveled to Bombay and then to an airdrome east of Calcutta.*
- *For the next six months, the shirt was laundered after each wearing which was particularly hard on it because the Indians didn't use soap.*
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Reeves Army Twill is one of the Reeves Fabric Group, all of which have been invasion-tested, and are destined to do an outstanding peacetime job in work clothes and sportswear. *For further information regarding the post-war uses of these fabrics, write to our New York office or to any of our representatives.*

THE REEVES FABRIC GROUP INCLUDES: *Reeves Army Twill · Glengarrie Poplin · Reeveking Gabardine · Byrd Cloth · Marine Herringbone · Mountain Cloth · Warrior Twill*

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DETROIT 6, MICHIGAN

Increased production attained in precision machining this aircraft crankcase on Ex-Cell-O special-purpose machine.

On this Ex-Cell-O special-purpose machine, aircraft crankcase sub-assembly of aluminum alloy is *precision* machined automatically except for loading and unloading. Part is loaded from top over center post to assure rigidity. "Start Cycle" button is pressed, and machine drills, reams, spot-faces and chamfers 16 stud holes in each of 14 deck pads (total of 224 holes, two operations per hole), then stops, ready for operator to unload and repeat the cycle. This part was formerly machined one bank at a time. Now, with this Ex-Cell-O machine, handling and operation time is exactly one-half what it was; error between banks of holes, radially and vertically (due to reloading of part), is eliminated; also, by one machine only now being required for the job, floor space is saved.

Ex-Cell-O precision four-way drilling and reaming machine with automatic seven-station index fixture.

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EX-CELL-O *makes* Special Multiple Way-Type Precision Boring Machines • Special Multiple Precision Drilling Machines • Precision Thread Grinding, Boring and Lapping Machines Broaches and Broach Sharpening Machines • Hydraulic Power Units • Grinding Spindles • Drill Jig Bushings • Continental Cutting Tools • Tool Grinders • Fuel Injection Equipment • R. R. Pins and Bushings • Pure-Pak Paper Milk Bottle Machines • Aircraft and Miscellaneous Production Parts

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THERE'S many a mechanism today doing a *better* job—*longer*—because of specified engineering principles applied to the springs. Automatic mechanical action calls for springs with the PEP to produce continued reliable action, and the POWER to perform the desired function. Only sound engineering can provide *both* for individual performance requirements.

We have seen this in mechanical developments of the past. The unparalleled demands of this war have demonstrated it to a remarkable degree. Improvements and new devices to come will benefit from just such knowledge.

From now on, make sure you get the best mechanical action by using Barnes-made springs with *Engineered Pep and Power.*

Barnes-made Springs

ENGINEERED PEP AND POWER

WALLACE BARNES COMPANY DIVISION OF ASSOCIATED SPRING CORPORATION
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Actual photo of a Gulf Service Engineer (left) consulting with Foreman in plant of prominent Texas aircraft engine manufacturer on cutting oil requirements for milling master connecting rods.

"With soluble oil, average production on this profile miller was 16 master connecting rods per shift," says this Foreman. "With Gulf L. S. Base and Gulf Cut-Aid, we were able to step up the feed, which resulted in a production increase of 7 rods a shift—and smoother milling with Gulf Cutting Oils helped us eliminate burring and filing."

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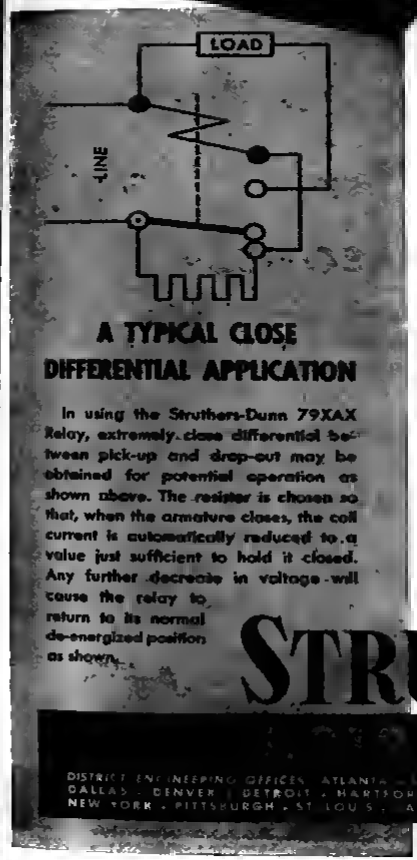
...in a new, simplified design



The new, simplified construction of the Struthers-Dunn Type 79XAX Sensitive Snap-Acoon Relay makes it particularly suitable for a wide range of applications because of its ease of adjustment. Snap-action design assures full normally-closed and normally-open contact pressures. Erratic operations and varying contact resistance encountered with ordinary sensitive relays, due to slowly changing coil flux balancing armature spring tension, are eliminated.

The armature of the 79XAX almost completes its travel in either direction before the contacts snap into the new position. This feature permits an unusually broad range of use from vacuum tube circuits, to overcurrent protection, pulsing circuits, and jobs where extremely close differential or extreme sensitivity of operation is required.

The standard adjustment using 60 ampere turns in the coil at approximately .02 watts results in contact pressures of 5 grams with contacts rated 5 amperes, 115 volts a-c; or 0.5 amperes, 115 volts d-c, non-inductive. Contact ratings up to 10 amperes, 115 volts a-c may be obtained with 100 or more ampere turns and a corresponding increase in power. A sensitivity of 0.005 watts, with 30 ampere turns, is obtainable with reduced contact pressures and ratings, and at an increase in price of the unit.

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A PATENTED "ROCKING CHAIR"

BY J. FREE HENRY

Publisher of "Skyways" tells how Bell Aircraft developed a method for forming plastic cabin tops for military fighters that eliminates surface defects and improves visibility.

The patented "Rocking Chair" method was used to form the plastic cabin tops on these P-63 Kingcobras, shown here as they are being prepared for fly-away delivery to Russia over the Northern Route.

"BELL AIRCRAFT has made an impressive record in developing new methods—not only for improving the fighting performance of our war planes but also for developing many innovations which have greatly speeded up production. One outstanding example is Bell Aircraft's patented machine for molding its transparent plastic cabin tops and canopies.

"Before 1940, these cabin tops and hatches were made by manual methods, too slow for the tempo of scheduled war production. Four men had to pull a sheet of hot plastic over a cotton covered form. It took time, and impressions from the cloth sometimes appeared in the canopy, impairing clear vision.

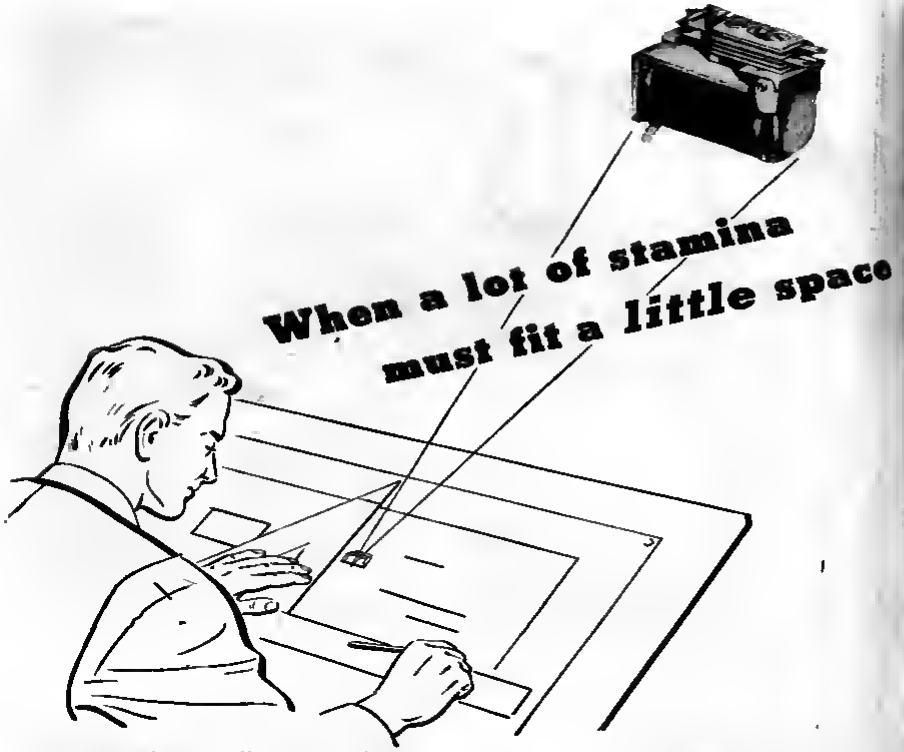
"One day it was discovered that if there was controlled, constant movement between the plastic sheet and the mold form, many of these defects could be eliminated.

"Utilizing this principle, Bell Aircraft engineers invented, and patented, a stretch-forming machine which keeps the hot rubbery thermoplastic in constant motion—rocking the form until the sheet of material has reached its proper contour and cooled to its final shape.

"This ingenious mechanical 'rocking chair' turns out plastic cabin tops which are not only accurate in form but also of greatly improved optical quality. By the patented Bell Aircraft method a finished clear top comes out of the 'stretcher' every seven minutes and two girls are the sole operators.

"They say that necessity is the mother of invention. During this war Bell cogineers have developed many other time and labor-saving ideas which, like the patented 'rocking chair' have helped advance aeronautical science by decades, making possible improved manufacturing methods not only for war but for peacetime production as well."

★ *Buy War Bonds and Speed Victory*



When a lot of stamina must fit a little space

IF SPACE requirements dictate a small relay —and service conditions a powerful one . . . here's the relay to fit your needs. It's the Automatic Electric Class "S" Relay—tiny in size, light in weight, but dependable and packed with power.

Class "S" Relays have been designed especially to meet the exacting conditions of service on fast, modern aircraft. They offer a combination of features never before found on any relay, large or small. For example:

1. Vibration-resistance is not just "added on"—it's designed right into Class "S" Relays. And they withstand with a large margin of safety the most rigorous operating tests of the Signal Corps and the Air Forces.
2. A unique spring design provides high contact pressure within small space limits.
3. An added assurance of reliability is provided by twin contacts.
4. The new type of pin-pivoted armature with full length bearing provides the Class "S" Relay with exceptionally long life even under the toughest conditions.

The Automatic Electric Catalog gives full details. Write for your copy.

Relays AND OTHER CONTROL DEVICES by AUTOMATIC ELECTRIC

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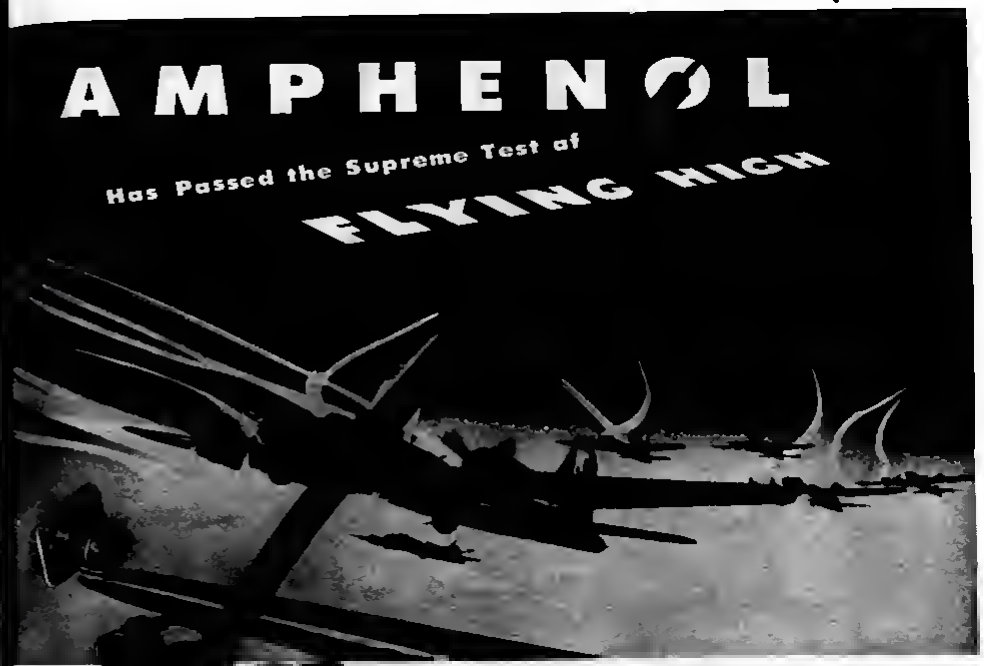
Has Passed the Supreme Test of FLYING HIGH



Wherever American planes go, Amphenol products go with them—even into the upper stratosphere where severest conditions are experienced. They may be A-N or British connectors, perhaps cable assemblies, perhaps synthetic conduit, or the aristocrat of electrical wiring—RG Cable and U.H.F. connectors. In many planes you will find them all.

Some types are available for work in pressurized quarters, others where explosion-proofing is vital. There are some that are used because they can stand contact with oil, or acid or water. Regardless of where you find them, Amphenol products have earned the right to be there by passing every required test and by performance on many a firing line.

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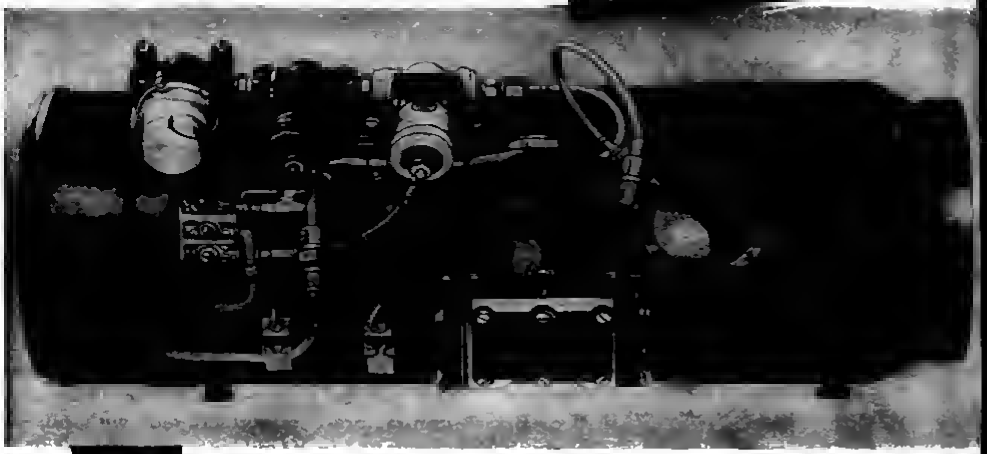

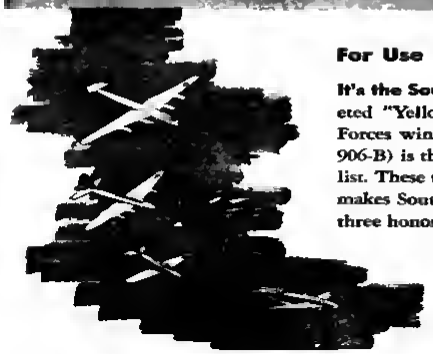

For Use In Everything from Fighters to "Flying Box Cars"

It's the South Wind—906-A. This is the *first* aircraft heater to get the coveted "Yellow Dot"—the *only* heater found to comply with the Army Air Forces winterization requirements. What's more, South Wind 906-A (with 906-B) is the *first* heater to get on the Navy Bureau of Aeronautics approved list. These two firsts, added to the Civil Aeronautics Administration approval, makes South Wind 906-A the first aircraft heater in history to have won all three honors.

Stewart-Warner

Five Great Advantages of the Triple-Approved South Wind 906-A

1. "Accelerating Flow," brought about by the unique spiral shape of the tapered flue passages, permits more heat output with less weight and space, because of its increased efficiency.

2. Thoroughly Tested, the heater has proven to be readily started and reliable in operation at low temperatures and high altitudes.

3. Doubly Sealed from the fuel line and its connections, and completely sealed from the combustion gases, the ventilating air cannot become contaminated with fuel, smoke, inflammable vapors, or noxious gases.

4. Sealed from Dirt and Moisture in the duct air, the electrical controls are mounted externally of the heater for ready accessibility.

5. Simply and Strongly Built, with obvious quality, the heater is engineered and manufactured to withstand the rigors of aircraft or ground uses with a minimum of maintenance.

*FOR THESE OPERATING CONDITIONS

Altitude Range Feet	Combustion Air pressure drop across heater—Inches of water	Heat Output as determined by position of "high-low heat" switch
0-20,000	5-35	High and Low
20,000-35,000	5-35	High
35,000-44,000	7-35	Low

Minimum recommended starting temperature . . . . . —70° F.
Maximum recommended starting altitude . . . . . 20,000 feet
Recommended fuel pressure 14 to 15 lbs./sq. in. gage at heater.
Required voltage at heater—24.0 to 28.5 volts.
Heat output (in high heat) 50,000 BTU/hour.
With ventilating air rate of 15 lbs./min. (or more).
With combustion air rate of 1 to 2 lbs./min.

Heater mounted horizontally or vertically with fuel nozzle at top.

Applies to: Model 906-A heater equipped with Model No. 473460 Combustion air regulator valve.

• This heater was engineered to provide a heat output of 50,000 B.T.U.'s per hour with the utmost safety, reliability and service ability. Compact—it gives top performance in everything from fighters to "flying box cars." It is operated entirely independent of the airplane engines, requiring only gasoline under pressure, electricity, and the flow of air.

Write today for complete technical details on Model 906-A. New illustrated catalog is FREE!

South Wind Heating

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HEATER DIVISION OF STEWART-WARNER CORPORATION, CHICAGO 14, ILLINOIS

West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service, 1273 Westwood Blvd., West Los Angeles, California

KEY TO COMPACT DESIGN

YOU can use Switchettes to control several circuits from a single location. They can be actuated by cams in selector switches, or by a bellows or lever in limit switches. Whichever way you use them, G-E Switchettes help you save space and make your equipment more compact.

Note the dimensions: 1¼ by ½ by ½ inch. Yet the Switchette handles up to 10 amperes at 24 volts d-c (230 volts a-c), and is sturdy enough to withstand millions of mechanical operations.

Its small size, its lightning-fast snap action, and its ability to resist high physical shock and vibration make it ideal for built-in applications on electric control equipment that has to "take it." Best of all, because of its unusual double-break contact structure, it simplifies the solution of many tricky circuit-control problems.

Don't handicap your important designs

Your plans for a smaller, lighter, or more compact equipment need not be stymied by the lack of a suitable make-and-break contact mechanism. More than 200 modifications of the Switchette are ready to meet your needs. In addition, we have a variety of limit switches, transfer and selector switches, push-button stations, thermostats and timers built around the Switchette. Perhaps you can use some of these ready-made devices to advantage.

Send for a catalog

If you don't already have a copy of our Switchette catalog, ask the nearest office for Bulletin GEA-[illegible]. If none of the forms listed in the catalog meet your needs, our engineers will be glad to work with you to adapt them. *General Electric Company, Schenectady 5, New York*

PRECISION PRODUCTS AND ENGINEERED SYSTEMS FOR AIRCRAFT

GENERAL ELECTRIC

On the Wing! Here the leading edge of a mammoth JRM wing dwarfs a Martineer. No hastily converted bombers, no untried designs, JRM Mars are built from the ground up as overocean transports.

". . . There's A Way!" Big shipways like these are needed to build Mars flying boats. Other ways lie on either side of this one. Such complete facilities will help reduce costs of postwar commercial versions.

Thousands of A.-Coupons would be needed to fill the gas tanks shown above . . . of a single JRM Mars. These 82-ton giants will carry useful loads of more than 20 tons, operating at 10c a ton-mile, or less.

Tooled and equipped for prompt delivery of

MARTIN MARS AIRLINERS!

IN a year of service with the Navy the Martin Mars has demonstrated convincingly her outstanding performance characteristics. She's carried useful loads of over 35,000 lbs.—flown non-stop 4,227 miles—operated, under war conditions, at 15c per ton-mile. But sensational as her performance has been, there's another and equally important fact that recommends Mars-type transports to overocean airline operators.

Prompt Postwar Delivery

Airlines ordering commercial versions of the Mars, when Victory finally comes, will have no long wait for designing, tooling, testing and ironing out "bugs." Martin assembly lines are fully tooled *today*, for production of 20 more Mars transports for the Navy. Moreover, a year's service has thoroughly tested the Mars, yielding developments which are being incorporated in her 20 sisterships. Result: prompt delivery of Mars transports, which will permit airlines ordering these planes to "get the jump" on competition.

Write for Information

Orders for commercial versions of the advanced Mars are now being taken for postwar delivery. Companies currently in overocean air service or planning such service after Victory may obtain complete information about the Mars from the Glenn L. Martin Company, Baltimore 3, Md.

Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

Crankshaft of Ranger twelve-cylinder inverted V-type inline engine with connecting rods in place, showing (arrows) Needle Bearing equipped counter-balances.

Dampener assembly. One bolt is secured through Torrington Needle Bearing, while second bearing is held in place for insertion of second bolt, completing assembly.

Dis-assembled view shows counter-weight parts, and detail of the modified Type FT Needle Bearing.

Needle Bearings Carry Crankshaft Counter-Balance on Ranger Aircraft Engines

Here is an interesting application of Torrington Needle Bearings—a "cam-follower type" application—in the design of the crankshaft counter-balance of the Ranger twelve-cylinder, inverted V-type inline aircraft engine.

Two modified Type FT Needle Bearings are used to support each counter-weight, which in turn serves as a vibration dampener to provide dynamic balance on the crankshaft at high speeds.

Here again the characteristic advantages of Needle Bearing design are readily apparent: their high unit capacity due to the large number of small diameter rolls; their comparatively small O.D.; and the simplicity of their installation make them ideal for this and many other applications where dependability and long, maintenance-free service life are essential.

Perhaps these features will suggest an application where you can use Needle Bearings to improve efficiency, increase service life or effect cost economies through simplification of design or production steps.

Remember—there's a type and size Torrington Needle Bearing to meet virtually every requirement. If you haven't the latest information on file for ready reference, send today for our combined catalog and application handbook, No. 30-A.

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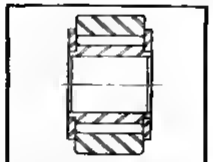

The FT Torrington Needle Bearing designed for Heavy Rolling Loads

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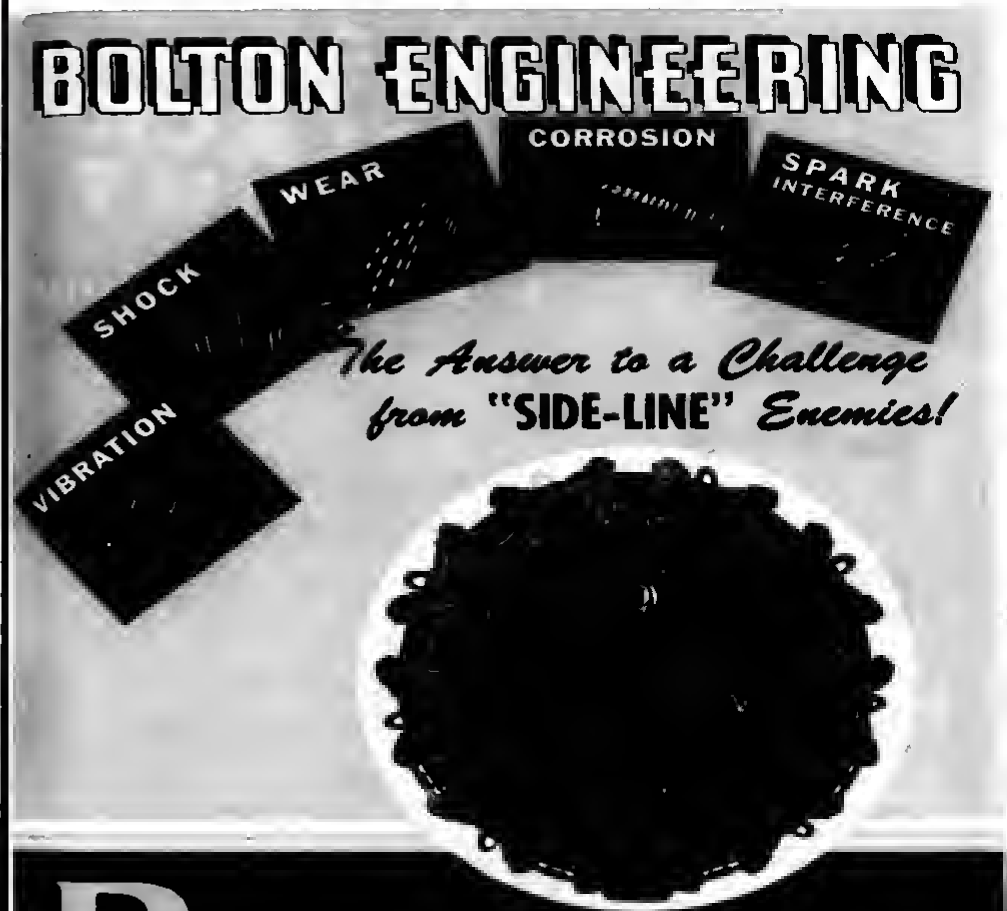

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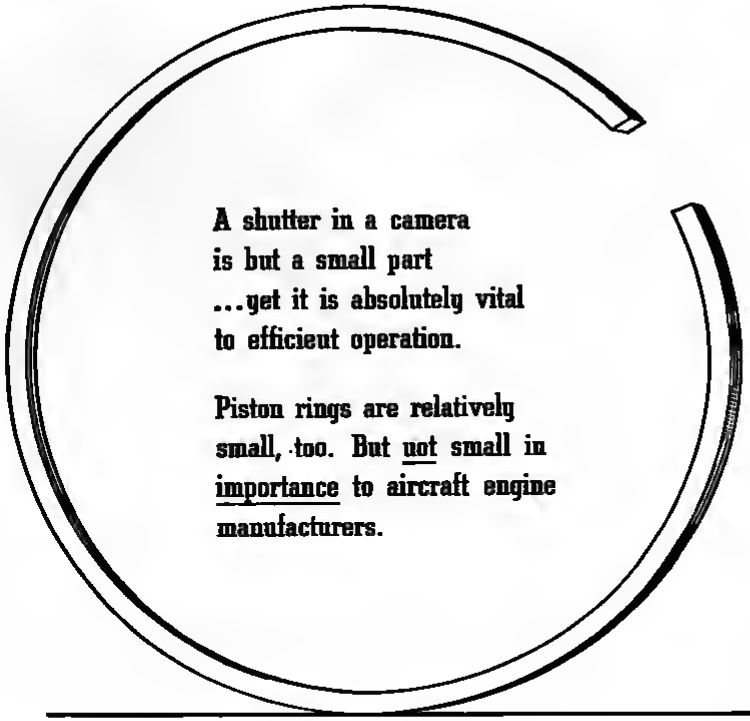

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Piston rings are relatively
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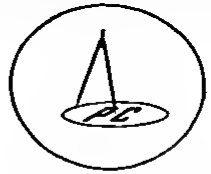
manufacturers.



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*Trade Mark †Pat. Pend.

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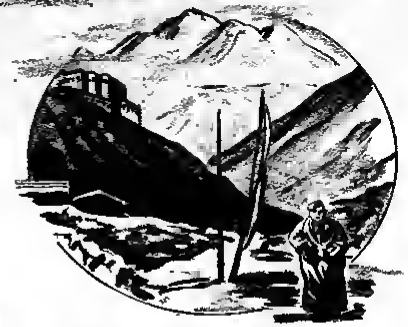

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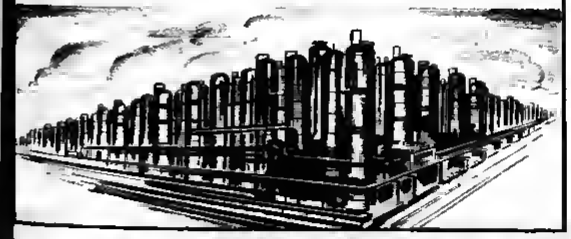

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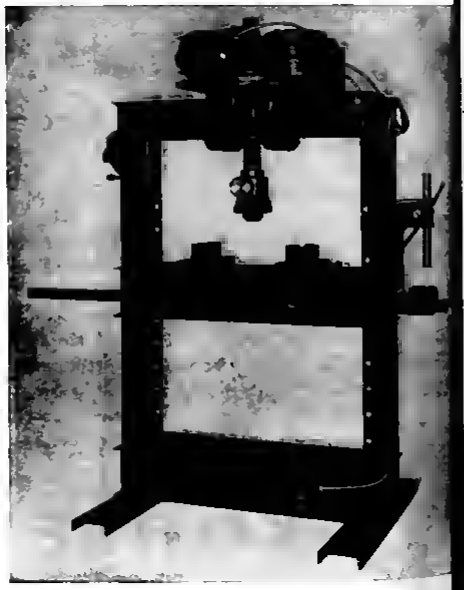

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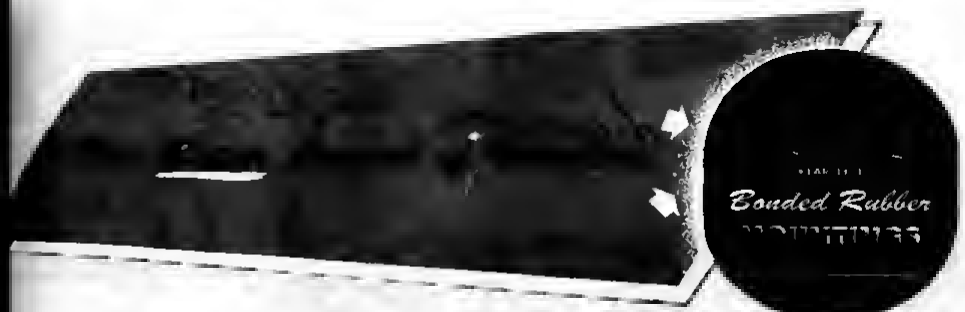
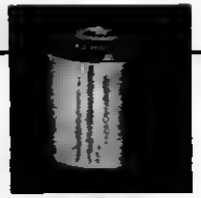
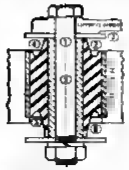




TUBE FORM



1. End Extensions—Provide clearance between the metal members for free movement in shear
2. End Shape—Throws flexing action away from the metal parts into the rubber body, preventing stress concentration at the edge of the bond
3. Rubber-to-Metal Bond—Lord Methods produce a high ratio of bond strength to working stress, resulting in a large factor of safety
4. Rubber Compounds—Developed particularly for shear type mountings and may be changed in properties to suit a wide range of conditions.
5. Center Sleeve—Dimensions may be changed to meet any unique installation conditions.
6. Sound—Use of Lord mountings eliminates noise normally transmitted through solid metallic paths
7. Safety—Metal washers, installed as shown, limit movement under ordinary overload or shock. If excessive overloads cause the rubber to fail the suspended member will not be released without breaking one of the metal parts

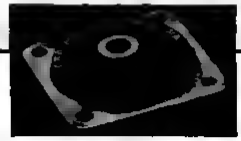
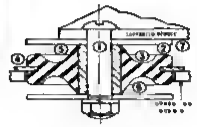


PLATE FORM



1. End Extensions—Provide clearance between center metal member and rubber Snubbing Shoulders for free movement in shear
2. Snubbing Shoulders—Arrest shock movement and supply a cushioned stop to contact with metal washers.
3. End Shape—Throws flexing action away from metal parts into the rubber body, preventing stress concentration at the bond
4. Rubber-to-Metal Bond—Lord Methods produce a high ratio of bond strength to working stress, resulting in an ample factor of safety
5. Rubber Compounds—Developed particularly for shear type mountings may be changed in thickness of body and in properties to suit a wide range of conditions.
6. Sound—Use of Lord mountings eliminates noise normally transmitted through solid metallic paths
7. Safety—Metal washers installed as shown, make up an interlocking system of metal parts, which limit and cushion excessive movement under conditions of overload or shock

FOR more than twenty years Lord's business has been the isolation and control of vibration. Lord has lifted the methods of attack on the destructive forces of vibration to a highly developed science. When Lord engineers make a study of your plant or your product, there's no guesswork about their recommendations.

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DeVilbiss has accumulated a reservoir of information on modern ways to use and handle air to best advantage in your work. Consult your aviation supply distributor or write the factory direct.

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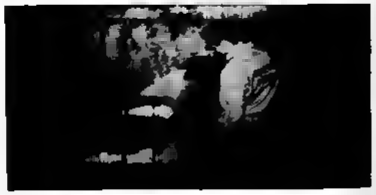

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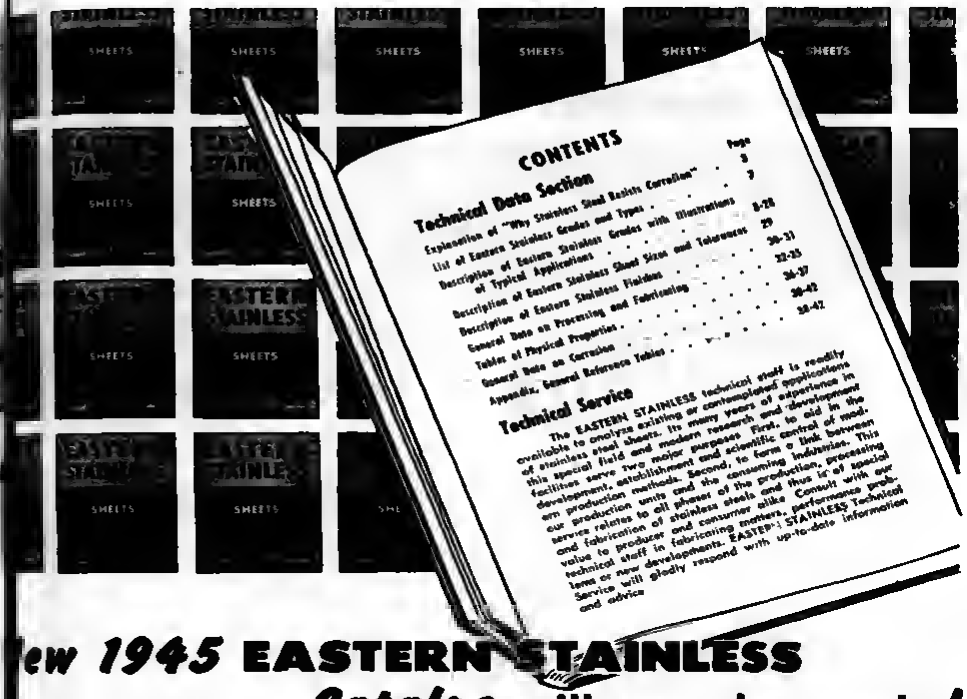

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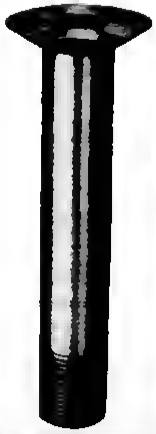

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Fig. 1

Fig. 2

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Especially designed to cut the new, tough materials, the Zephyr is speeding through work in war plants. And, these light-weight materials are here to stay—will be used for thousands of civilian products. The Zephyr cuts them as easily as the Black Widow zooms through flak-infected skies.

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The Inside Story of Zephyr in pictures sent on request

...ning a metal spinning in a plant where ...k cars and truck bodies are made.

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In dive bomber — pursuit ship — "Flying Fortress" — precision must be proved to a certainty before becoming an integral part of the p vital equipment. It is "combat reliability" such as this that is engineered every A-P-built Hydraulic Aircraft Control.

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This technical information sheet provides the design-engineer with pertinent electrical and physical characteristics...including impedance, capacitance, attenuation, diameter, materials, and weight ...for Federal's wide variety of high-frequency cables.

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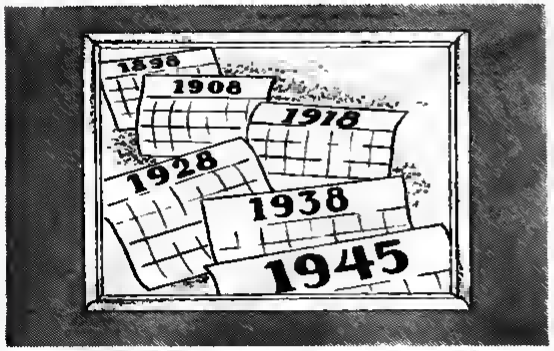

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THE huge reservoir of electrical engineering experience, stored up in 47 years of experimenting, improving, perfecting, is tapped with prodigal generosity to give you tools today in cutting work-hours per job, speeding production, reducing costs.

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SPECIAL ¼" HEAVY DUTY AVIATION DRILLS

MODEL 14 ARS
7½ in. long
Weight 3¾ lbs.

MODEL 14 ARD
7½ in. long
Weight 4¼ lbs.

Ball bearing throughout. Quick make and break switch, with locking pin in center of trigger. Universal motor operating on direct or alternating current. Chrome nickel steel gears, heat treated, packed in grease and sealed. Equipped with 3-jaw, screw-back chuck; rubber covered cable and attachment plug.

THE United States ELECTRICAL TOOL CO.
CINCINNATI 14, OHIO

"M"

STANDS FOR VICTORY...TOO

"That may sound like a trick remark to you folks on the home front, but I'm a lad who ought to know, so just let me 'shoot the breeze' a bit, and you'll see what I mean.

"Back around the turn of the year, I'm chauffeur of a Glory Wagon flying Purple Heart Corner on a milk run that isn't helping the Axis Supply Lines any. With forty-one successful missions over this same area . . . I guess we kind of overlooked that swell cover the pea-shooter boys had been giving us . . . Then all Hell broke loose around our ears. . . . . .

"For next time over, a weird looking bunch of bandits blitzed through us, and dished out such a mauling that the guys who got back sounded as wacky as the tale of the farmer who saw his first giraffe and yelped, 'There ain't no sich animal'. . . . . .

"So we learned about jet-propelled Jerries the hard way and the beatings we took the next few trips did little but swell the flak-happy circle . . . for nothing we had seemed to be the answer. . . . . .

"But sooner than we'd any right to hope for, we found out, . . . and so did Mr. Goering's smug thugs . . . Flying top cover on our next mission came an escort of new THUNDERBOLT M's* that A-2 had been so hush-hush about . . . They looked just like any other 47's to my jaundiced eye . . . and probably to the eager beavers from Berlin. . . . . .

"We were both wrong . . . but this was their turn to take it, and no foolin'. . . . . .

"My geese were just lining out for their run, when down came the 'jets' again . . . but what a kick we got when right on the tail of these super-doopers streaked those THUNDERBOLT M's . . . diving three feet for every two of the startled Heinies. . . . . .

"Well, THUNDERBOLT fire power is no secret . . . and with this amazing increase in speed, it was just too bad for those new toys of the 'Supermen' . . . The 'jets' that were left, kept right on going and they haven't troubled us too much since . . . The Luftwaffe had thrown its Sunday punch . . . and found out again . . . that we had a wallop to more than match it."

*** THE PERFORMANCE OF THE THUNDERBOLT "M" AND ITS PILOTS HAS ESTABLISHED NEW STANDARDS OF PROTECTION.**

REPUBLIC AVIATION CORPORATION

...s of the Mighty Thunderbolt » » » *Farmingdale, L. I., N. Y.* • • *Evansville, Ind.*

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Rotate on a
CURTIS UNIVERSAL JOINT

The Link Trainer is a product of Link Aviation Devices, Inc., of Binghamton N. Y. Curtis Universal Joints are built to meet the exacting standards of the Aircraft Industry and to equal Class I Specifications of the Army Air Forces.

...to the men in a
LINK TRAINER

A vital part in the Link Crew Navigation Trainer used to train United States Army Air Force pilots, radio operators and navigators, is the Curtis Universal Joint which supports the fuselage on the top of the 18-foot tower, beneath the celestial dome.

This Curtis Universal Joint mounting leaves the fuselage free to bank, pitch and turn within the angular limits normal to instrument flying. It is a unique application of the Curtis Universal Joint principle which is the answer to transmitting out-of-line motion or power, or rotating shafting around corners.

In every phase of their training, and right up to the time these men are in actual combat, they will find Curtis Universal Joints used in almost any plane they fly — in engine controls, retractable landing gear, control flaps and auxiliary power controls.

Also a great many machine tools which build the planes use Curtis Universal Joints in hundreds of applications where a precision product of proven strength and long-wearing quality is required.

Let Curtis Engineers help you in your universal joint problems — if a "Standard" Curtis unit, either single or double, will not meet your needs, we can design a joint that will.

CURTIS UNIVERSAL JOINT CO. INC.
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COLLINS 1000-C MULTI-CHANNEL TRANSMITTER

Smart engineering design halves the cost per channel

THIS 2500 watter, Collins engineering has struck an ingenious balance of quality, *and economy*.

The right hand cabinet contains two vertical rf sections. Through application of the [illegible] of quick shift (less than 2 seconds) each section can be used interchangeably on [illegible] channels, such as may be called for by day and night transmission. These channels [illegible] not limited to the pass band of the rf circuits but may be located anywhere within the [illegible] range of the equipment—2 to 20 mc.

The cost per section is comparable to that of conventional single channel sections. The [illegible] cost per channel is thus cut approximately in half.

In addition, relays permit selection of three crystals per channel (six per vertical section) [illegible] within 2% of the nominal center frequency. Twelve frequencies are therefore [illegible]ailable in a single cabinet, arranged as needed within the four channels.

In the equipment illustrated above, the left hand cabinet contains the af and modulator [illegible]. The power supply cabinet is in the center. All sections are of highly advanced [illegible], and are of the vertical chassis type.

We shall be glad to discuss applications of this rugged, versatile [illegible]uipment to suit your operating requirements.

[illegible] Radio Company, Cedar Rapids, Iowa.

Available: Additional af-modulator and rf multi-channel sections . . . Supplemental Collins Autotune rf section . . . Frequency shift keying . . . Complete remote control, built to your requirements.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

A little Nickel makes landing SAFER for B-29's

No ordinary metal can curb the tremendous landing momentum of the world's mightiest warplane... the B-29.

It takes metal that does more than resist the shock, abrasive wear and galling of brake drums.

Essentially the metal must dissipate intense frictional heat from restricted surfaces. It must resist distortion and heat-checking under all kinds of adversities.

That's why experienced engineers specified an alloy containing nickel... nickel-chromium-molybdenum (high carbon) iron... for B-29 brake drums.

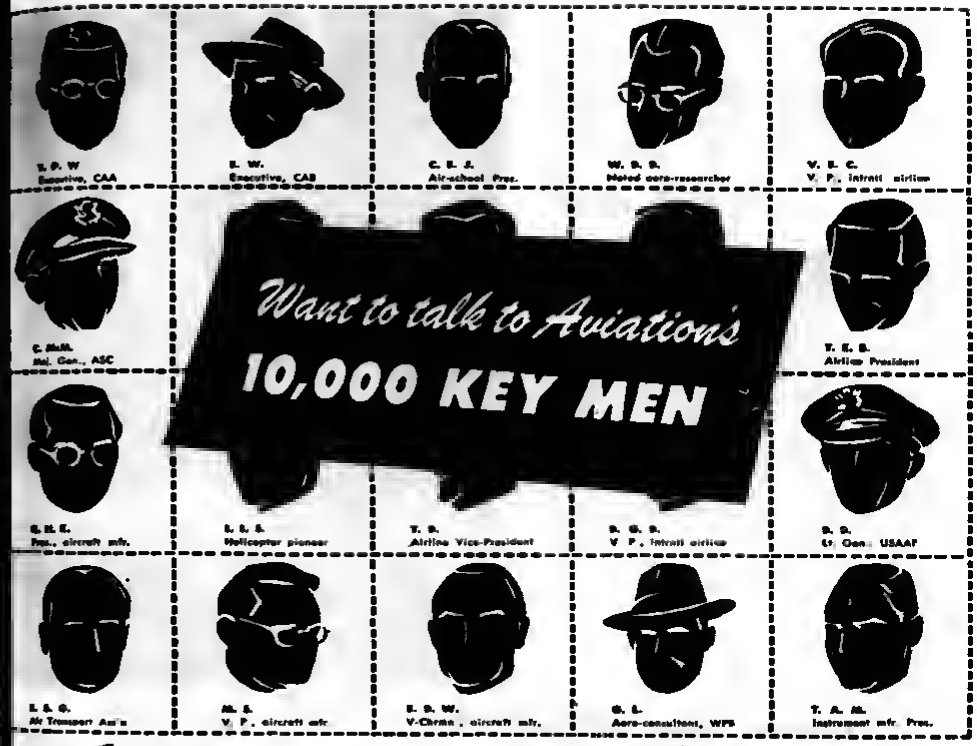
Centrifugally cast against a steel shell, this nickel alloy iron provides a machinable structure in the light-sections involved. The composite design gives the important combination of strength and heat-and-wear resistance.

These drums are aptly given the trade name "Centrifuse" by Centrifugal Fusing Company, a supplier of those used on large bombers. "Centrifuse" drums are also used on other types of aircraft... and on combat cars and armored vehicles.

These outstanding brake drums illustrate once more the product improvement which can be made with Nickel. An alloy containing Nickel may improve your product. We invite consultation on the use of Nickel or Nickel alloys in your equipment.

Close-up view of a section cut from a typical Centrifuse brake drum, showing fusion between steel and alloy iron. Besides resistance to wear and to heat-checking, other advantages include minimum scrap loss and maximum soundness in the product. Range of sizes run from 8" to 20" diameter. Centrifugal Fusing Company alone has produced over 4,000,000 pounds of such castings.

THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street, New York 5, N.Y.



Glad to arrange it—any Monday

They're busy men, of course, filling their vital positions in the aviation industry. Their days are booked solid. They have little time for interviews.

But part of their every-Monday-morning routine is to read *Aviation News*, the magazine which keeps them swiftly and accurately informed on *all* aeronautical developments.

It's a safe bet that these men are interested in your story. Since they are the men who make aviation's buying decisions, they *must* and *do* keep informed on aviation products and services as well as news.

These 10,000 men are top executives of our aircraft builders and of the plants which supply parts, equipment, instruments, and accessories... military officials and civilian administrators who direct government aeronautical interest... leaders and planners of U. S. airlines... distributors of tomorrow.

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RIVET *with an* AIR-BUCK

Wherever aluminum rivets up to 7/16" diameter are to be driven and where it is possible to use a yoke-type tool, as on subassemblies, the Air-Buck Riveter can be used to a very definite advantage.

By means of a yoke, this tool does its own bucking-up, requiring but one operator. In addition, it further simplifies the riveting operation by driving the driven head to a predetermined and adjustable height and then automatically shutting off when this height is reached.

CONSIDER THESE AIR-BUCK ADVANTAGES

- Minimum of experience needed to produce perfect riveting.
- Lighter and smaller than other yoke-type riveters of similar capacity.
- Automatic shut-off produces driven heads of uniform height.
- Riveting cycle can be completed or interrupted as desired.
- Inspection period permits alignment of rivet in hole.
- Extra clearance for passing over ribs instantly available.
- Easy to hold—recoil of the hammer is transmitted through the yoke and helps to buck up the rivet.
- Wastes no air. All air is utilized for doing work.
- Capacities range from 1/8" to 7/16" size rivets.
- Yokes of different sizes are easily interchanged.

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A-552

ONLY 10 TO 25 STROKES AND PISTON RINGS FIT CYLINDERS PERFECTLY!

FULMER PISTON RING LAPPER

TO "break-in" new piston rings in an aircraft engine formerly required anywhere from 6 to 24 hours of test stand operation of the engine under a light load. The Fulmer Piston Ring Lapper cuts this time down to a few minutes!

Only 10 to 25 strokes of the machine are normally required to lap in a conventional set of rings. There is no guesswork as to how rings fit the cylinders—this can be *seen* before the engine is built up!

The cylinder capacity is up to 6½ inches bore; larger capacities can be supplied on special order. Widely used by the Armed Forces.

The Fulmer Piston Ring Lapper eliminates the need for tearing down the engine because rings do not "seat" properly. It assures peak performance—the aircraft engine can carry full throttle right from the start, with maximum power and proper control of lubrication.

**Write today for complete information*

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...Dependable In Peace

In helping to sustain fighting horsepower on the wing, Dole Aircraft Valves and Fittings have met the battle test in protecting the smooth functioning of gas, oil, air, oxygen and other vital supply lines—faithful proof of good design and engineering—and precision manufacture.

Out of the testing laboratory of war will come many improvements that will mean dependability in peacetime applications to aircraft and other industries.

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Of shoes—and ships—and sealing wax—"

What Alice found "through the looking glass" was no more wondrous than the new world of petroleum as seen by Cities Service scientists...in this true Wonderland of Research the black gold of oil serves an ever-growing list of needs...Yes, it polishes SHOES ...and powers SHIPS...and SEALS preserves...and does a lot of other things that hold bright promise for tomorrow.

IN this war, Cities Service is represented on the battlefronts with everything from gasolene and lubricants to highly developed specialties, such as Cities Service Anti-Corrode, Insecticides, Detergents, Plastics and Explosives.

And to this list we have recently added tremendous quantities of 100-octane aviation fuel—enough to send great fleets of heavy bombers over Germany every day—as well as enough butadiene capacity to supply one-eighth of the nation's normal rubber demands. Such are the amazing production figures of the new Cities Service Refinery at Lake Charles, Louisiana—one of the world's largest and most modern refineries devoted to Victory!

When peace comes, you can look to Cities Service for important new developments. For the beginnings of this company go back almost as far as the Petroleum Industry itself!

In the future as in the past, Cities Service will continue to pioneer.

Progress through Service—

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LINEAR

Correct Design . . . Maximum Efficiency

TYPICAL HYDRAULIC ACTUATING CYLINDER

. . . showing applications of **LINEAR *Packings and Seals***

IN the design and testing stage, on drawing boards and in laboratories, new hydraulically actuated mechanisms are being readied for addition to the wide range of applications to be found in various fields today.

Busy war plants step up production by means of hydraulic cylinder controls for work feeding on lathes, screw machines, planers and surface grinders, for control functions of centerless grinders and for extruding, forging and pressing equipment.

On shipboard, hydraulic cylinders operate steering, clutch and throttle controls smoothly and effortlessly. Slow, clumsy manual controls on farm machinery, for scraper, dragline and plow operation on earth-moving equipment and road machines, have been replaced by the efficient, dependable actuation of hydraulic cylinders.

Top performance of hydraulically operated cylinders is impossible without a fluid-tight seal from peak to zero pressure. Linear packings effectively seal in the hydraulic fluid from source to point of application because . . .

They are designed correctly for maximum efficiency.

Their composition renders maximum resistance to fluids and pressures encountered.

They are precision formed for trouble-free operation and ease of installation.

Linear designs and moulds all types of synthetic hydraulic seals and packings . . . for the smallest applications . . . and for the terrific pressures of giant hydroelic presses. Qualified and equipped to test the physical properties and performance of the finished product, completely and accurately. Linear's facilities for the design of the hydraulic unit itself are at your disposal.

The consultation of Linear engineers is available . . . ask Linear to cooperate with your designers in stepping up the efficiency of your hydraulic products. Sample rings upon request

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A new time-saving, cost-saving device for the precision cutting of internal grooves in bores or housings.

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● Can be used in any automatic or hand drilling or reaming machines; it assures a concentric recess, without scratching or marring. Because it operates by fingertip pressure, it is especially suitable for female workers. Skill is not a factor.

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Why take a chance on "Locking Open"?

Revolutionary Crown Zipper "two-way" track makes Crown the world's safest, most dependable zipper!

What happens when an ordinary zipper comes open *behind* the slider? Often the zipper must be replaced -- and sometimes the article to which it's attached.

But Crown Zippers are different. Even if the teeth *do* come apart behind the slider, there's no harm done. In two quick zips the slider can be moved backward along the track, then forward again, closing the entire track perfectly!

This is made possible by Crown's exclusive tooth construction. Both sides of each individual zipper tooth are identical, making Crown the world's *only* zipper with a smooth "two-way" track! And this is but one of *five* advantages Crown Zippers have over old-style zippers. (See complete listing below.)

That's why you can be sure that Crown Zipper applications in postwar aircraft equipment will give unfailing service--will zip smoother, further, faster, more securely!

Moreover, when you turn to postwar, Crown engineers, fresh from their experience in redesigning hundreds of military items, will adapt—or, if necessary, *create*--special zipper applications to meet special jobs.

Crown's new "double-acting" zipper provides opening wherever needed with smooth closures in both directions.

CROWN ZIPPERS are 5 ways better

1. Takes sharp curves

2. Die-cast for smoother action—extra strength

3. Provides opening wherever you want it

4. Won't lock open

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as Flawless as Fine Gems!

The C-46 CURTISS-WRIGHT COMMANDO TRANSPORT is equipped with this Carlson-processed cowl flap actuating cylinder.

SYMBOL OF SUPERIORITY IN CLOSE PRECISION WORKMANSHIP

OSCAR F. CARLSON COMPANY

2600 WEST IRVING PARK ROAD • CHICAGO 18, ILLINOIS

Skid load of aluminum stock is transferred, a sheet at a time, onto the belt conveyor at the feeding end of the coating machine in the background.

Roller coating section of the machine. Sheet already cleaned and dried is at hip height back of operator at right, advancing into the first coating rolls.

[illegible] Sheets a Day! . . .

Sheet stock is cleaned, finish applied on both sides, and dried in a continuous run through revolutionary machine at plant of leading aircraft manufacturer

SPEEDING UP production of vital aircraft components is forcefully illustrated at the plant of Douglas Aircraft Co., Inc., Park Ridge, Ill. Prior to the development of a revolutionary new machine, illustrated here, primers were applied to aluminum sheets by spraying. ★ ★ ★ Now these sheets are *roller coated*, at a rate of 3 to 7 per minute, which is many times faster than spray coating. In one continuous operation, the "Roller Coater" cleans, applies zinc chromate primer on *both* sides, and dries aluminum sheet stock at the Douglas plant. ★ ★ ★ Thus, what might have been a serious "bottle neck" has been entirely eliminated. It is just one example of how Pittsburgh is working hand-in-hand with producers of critical war materials to finish the job faster!

Pittsburgh Aircraft Finishes

The Paint Division of the Pittsburgh Plate Glass Company supplies vast quantities of aircraft finishes for all types of planes, including the specially formulated Zinc Chromate Primer used in the Douglas "Roller Coater." Among other important developments is Pittsburgh FABSEAL, an impregnated fabric tape used in pressurizing aircraft cabins for high altitude flying. Expert advisory service is offered, and our extensive experience in the field can often save you time and money.

PITTSBURGH PLATE GLASS COMPANY, Industrial Paint Division, Pittsburgh, Pa. Factories: Milwaukee, Wis., Newark, N. J., Houston, Texas, Los Angeles, Calif., Portland, Ore. Diesler Color Division, Detroit, Mich. The Thresher Varnish Co., Dayton, O.

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From the Eighth, the Ninth, the Fifth . . . the Twelfth, Fifteenth, and other veteran AAF . . . they have been drawn to staff the Twentieth—only Air Force of global commands.

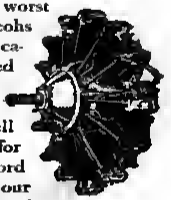
Operations wise, combat crafty, trial tested by English winters, sub patrols, Pacific distances, desert drought, tropic jungle . . . these men are well schooled in strategy and surprise, tactics and individual action. Stranger still—each is the cherished child of Luck who has surpassed the grim statistics of his trade, survived all dangers hostile skies can show.

Now in the great new gleaming bombers, these sons of Fortune can bring home to Nippon a boxcar load of bombs . . . and say with Scriptural certainty, that the Lord hath delivered their enemy into their hands!

In all the legends of fighting men, the rosters of the Caesars and great Genghis Khan, the scrolls of Charlemagne and the Crusades, the shining chronicles of courage . . . Earth has not seen nor History known their like before!

These are the Great Inimitables, incredibly of our day. Watch for the shoulder patch, with the "20" between the Air Force wings, and honor them for what they are! So much have these men given—and so much still is theirs to give . . . that no one of us can match their gifts, even in gratitude.

For the huge training program of the USAAF and our Allies, this company has manufactured more than 20,000 Jacobs engines—and over 10,000 of another make—for use in twin-engine planes used to school bomber personnel.



Used in training, subject to the worst wear known to plane engines, Jacobs engines delivered far beyond specification or expectation . . . have increased their rated service period between major overhauls from 350 to as high as 1200 flight hours . . . served well the student airmen, saved money for the taxpayers, and established a record for performance and stamina that, to our knowledge, is unmatched by any other engine . . . For transports, freighters, fee ler and lighter airplanes, there will be Jacobs engines suited to postwar needs, capable of continued performance, minimum maintenance and very low costs . . Jacobs Aircraft Engine Company.

JACOBS · Pottstown, Pa.

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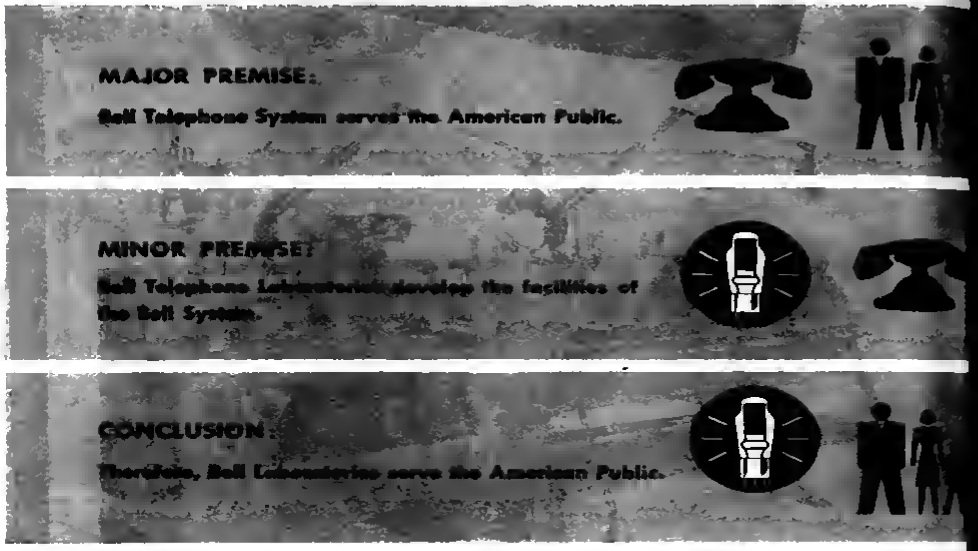

And that is the *raison d'être* of the Laboratories. For the Bell Telephone System, the Laboratories carry on research studies in all the sciences and development work in all the engineering arts that relate to electrical communication.

For the Western Electric Company, the manufacturing unit of the System, the Laboratories develop equipment, prepare specifications for its construction, and engage in various engineering activi

For the Armed Forces of the United States, under contracts of the Western Electric, the Laboratori have undertaken more than a thousand develo ment projects — many with spectacular effect u our enemies.

BELL TELEPHONE LABORATORIES *explore and invent, devise and perfect for our Armed Forces at war and for continued improvements and economies in telephone servi*

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In a KOLD-HOLD electrical refrigeration cabinet you can process metal parts and tools consistently at closely controlled temperatures as low as 150 deg. below zero—much lower than can be attained by the use of dry ice and the lowest temperature yet commercially available. This unit is especially designed for hardening steel tools, making expansion fits on close tolerance assemblies, for experimental work, and for product research.

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Beginning of the End -- of Tokyo

November 23, 1944, a fleet of B-29's lifted itself off the runways of Saipan—first raid of these sky-giants against the Japanese capital . . . a combination of men, machines, and determination that is being, and will be, repeated with increasing size and intensity.

In the spring of 1942, Doolittle's planes averaged 30 seconds over Tokyo. Two and a half years later, the world's mightiest bombers loomed high over the "sacred city", pin-pointed their targets, unloaded tons of bombs, and were away after more than 30 minutes over the city.

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Boeing has done a masterful job in designing and building these ships . . . as has Wright in the mighty engines that get them there *and back*. And numbered among the thousands of vital parts that go into these great Wright engines are CECO carburetors.

Chandler-Evans is proud of this opportunity to pay tribute to all those men and women who have a part in the success of these superb bombers . . . and is proud that the dependability and quality of its carburetors is such that they have been chosen to do their part, however small, in making it the beginning of the end — for Tokyo.

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You can have complete confidence in peacetime "U. S." Naugahyde. "U.S." Rubber Company scientists have developed a great many distinct coated fabrics for the armed forces and have coated millions of yards of nylon, rayon, cotton, and glass cloth for military purposes.

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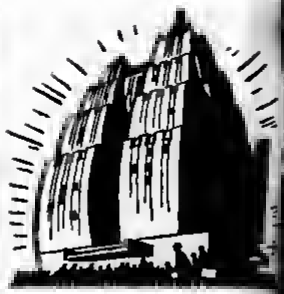

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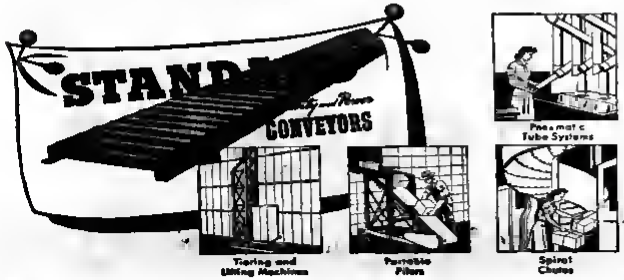

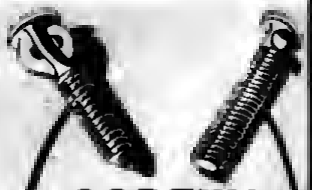

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Exide AIRCRAFT BATTERIES

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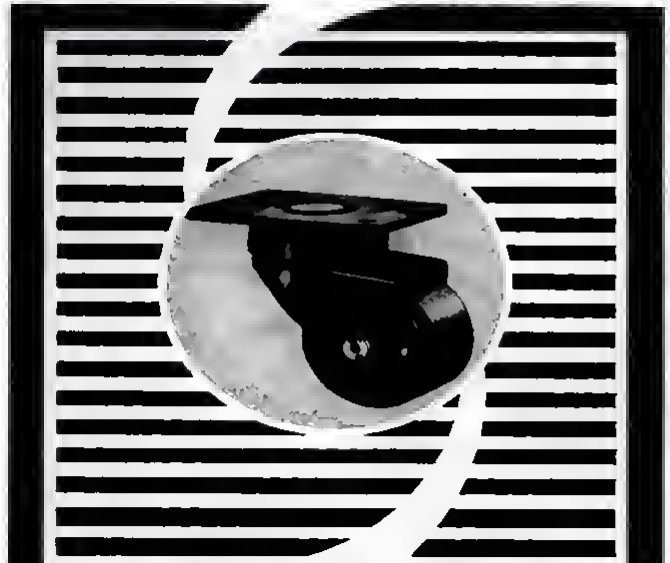

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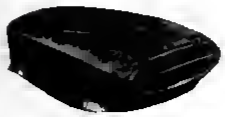

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As filtration specialists with years of laboratory research and practical engineering experience behind us, we candidly admit it is experience — actual experience under battle service conditions that has enabled us to produce the various Vokes Air, Oil and Fuel Filters now used on the many varied types of British, American and Allied aircraft and "kept them flying."

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Circo Chief DEGREASER

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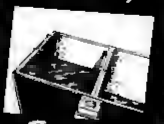

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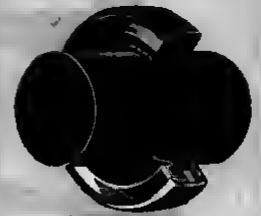

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Review of Patents

(Continued from page 227)

Control Device, relating to autopilots, is designed to provide means amount of elevator applied will directly with rate aircraft pitches ... to afford combined amount and follow-up system to minimize or ... elevator over-control and reduce ... Included is additional vertical ... air-spun horizon gyro for elevator with air pickoffs arranged to com... for precession in response to ... and additional balanced oil valve ... by barometrically responsive ... calibrated and manually adjustable ... desired altitude.—2,364,129, filed Apr ... pat. Dec. 5, '44, B. G. Carlson ... to Jack & Heintz, Inc.

Wing design includes blades telescopically extensible and contractible longitudinally, each fitted with paddle pivot... attached to blade end and connected ... cable in eccentrics on rotor shaft. ...ddles progressively change paddle rela... to path of movement so as to exert ...placement of air in one direction when ... predetermined points and to feather at intermediate points.—2,364,490, filed Dec. ... 41, pat. Dec. 5, '44, F. Vogel

...ng Mount for Automatic gun is intended to provide quick detachment of ...tire mechanism or only gun barrel for servicing operation, means for minutely adjusting training of gun, improved cartridge belt feeding and discharge of empty cartridge case and link.—2,364,500, filed ... 9, '40, pat. Dec. 5, '44, E. M. Bertran ... M. Sokol, assignors to Brewster Aeronautical Corp.

Convertible Wing Airplane utilizes feature of rotating usually fixed main airfoils about vertical axis to assist in landing in restricted space, with means provided to store propeller blades out of wing rotation path.—2,364,950, filed Sept. 11, '41, pat. Dec. 12, '44, V. N. Di Vozzi.

Book Reviews

(Continued from page 227)

AIR TRANSPORT AND CIVIL AVIATION Todd Pub. Co., Ltd., London, New York. 312 pages, graphs, drawings, directories.

Reference work including tables of present air routes throughout the world, an official directory, a "who's who" in air transport and civil aviation, and numerous articles on the subject.

AMERICAN AIR NAVIGATOR, by Charles Mattingly. Consolidated Vultee Aircraft Corp., San Diego. 230 pages, drawings, photos, appendix, index. $6.00.

Intended "primarily for the serious student of aerial navigation, and for those actually engaged in this interesting and vital profession," this book is strictly a training text and reference source for professional navigators.

THE SCIENTIFIC SELECTION OF SALESMEN, by J. L. Rosenstein. McGraw-Hill Book Co., N. Y. C. 259 pages, tables, index. $3.00.

Study of a technique for the selection of salesmen that "has been used successfully over a period of more than ten years." (This subject matter is judged of particular interest to executives in the aircraft industry as merchandising programs are readied for the postwar.)

FIGHTING WINGS, by Gilbert Paust & Milton Lancelot. Essential Books, N. Y. C. 256 pages, photos. $2.75.

Picture-and-text study of aerial combat in World Wars I and II. Necessarily terse, because of space limitations, the approach is a popular one. The technically minded will, however, also find it of interest in its many comparisons.

ENGLISH-SPANISH, SPANISH-ENGLISH DICTIONARY OF AVIATION TERMS, by Juan K. Serralles. McGraw-Hill Book Co., N. Y. C. 131 pages, $2.50.

In compiling this dictionary, the author has endeavored to make it completely in-

American, with emphasis on the technical terminology used in Latin America ... contains more terms adopted from ... than on the Spanish aviation vo... in which the influence of French ... is relatively pronounced."

...CTION ENGINEERING IN THE AIRCRAFT INDUSTRY, by A. B. Berg... McGraw-Hill Book Co., N. Y. C. ...7 pages. Illustrations, graphs, tables, ...operation, problems. $5.00.

...ludes principles illustrated by specific ... and questions and answers for the ...ion of common problems encountered ...e aircraft industry. Included is information on estimating new contract costs ... and scheduling direct labor ...material saving, statistical and ...cal reports, etc.

...NUTE TECHNICIAN, by Charles A. Zweng. Pan-American Navigation Service, N. Hollywood, Calif. 111 pages, ...porter. $1.00.

...ts multiple-choice-type examina... designed to prepare parachute technicians for written tests. Also includes ...ion on construction, operation, inspection and maintenance of parachutes ... tests of materials, parachute ... and Civil Air Regulations are ...

...CTION LINE TECHNIQUE, by Richard Muther. McGraw-Hill Book Co., N. Y. C. 320 pages, drawings, problems, index. $3.50.

...of the fundamental factors of production lines, compares production-line ... with job-lot manufacture, and ... how production lines are set up and ...ted.

...S AND USE OF HAND TOOLS, by R. R. Toliver. Wiley and Sons, Ltd., New York-London. 93 pages, drawings, index. $1.25.

...ith numerous illustrations of techniques ...mployed in the proper handling of hand ...ols used generally in machine shops this ...ook is specifically for mechanics and student-mechanics.

...ANALYSIS OF DRILL-JIG DESIGN, by J. I. Karash. McGraw-Hill Book Co., N. Y. C. 333 pages, photos, index. $3.00.

...n analytical, factual, systematic approach to the problems of tool design ... still true for a specific case study ...nd outlining fundamental principles that ...pply to varied degree to all tool design problems.

FUTURE FINANCIAL PROBLEMS OF CONVERSION IN THE AIRCRAFT INDUSTRY, by Tom Lilley and L. Laverne Hartsen. Harvard University, Boston. 50 pages. $1.50.

...ffering exemplary financial statements ...f an average airframe manufacturer, this ...ork gives a practical conversion perspective. Emphasis is placed on specific problems of the financial adjustments necessary during the transition from wartime ...o peacetime production.

ANNOUNCEMENTS—

of new machine tools, shop equipment and materials, electrical appliances, and aircraft parts and accessories are invited for inclusion in our New Products columns (see pages 229-248).

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable, and whenever possible glossy-print photos should be enclosed. Please do not send electros.

Manufacturers should address announcements to—

New Products Editor
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At 1 megacycle .064

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OIL RESISTANCE — A.S.T.M. D295-43T
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EFFECT OF CHEMICALS
Effect of 7 days immersion in solvents at room temperature; average of 3 tests in each solvent:

Solvent	Change in weight Per cent of weight of specimen as received	Change in dimensions Per cent of dimensions of specimen as received: Length	Outside diameter	Thickness
5 per cent sulfuric acid	+ 0.41	none	none	none
1 per cent potassium hydroxide	+ 0.83	none	none	none
Petroleum	+ 5.62	+2.6	none	none
Ethyl Alcohol	+ 1.66	none	none	none
Benzol	+ 21.9	+5.6	+10.9	—24.0

WATER ABSORPTION
Average of 5 tests

Water absorption, per cent by weight of dry specimen	0.65
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in thickness	none

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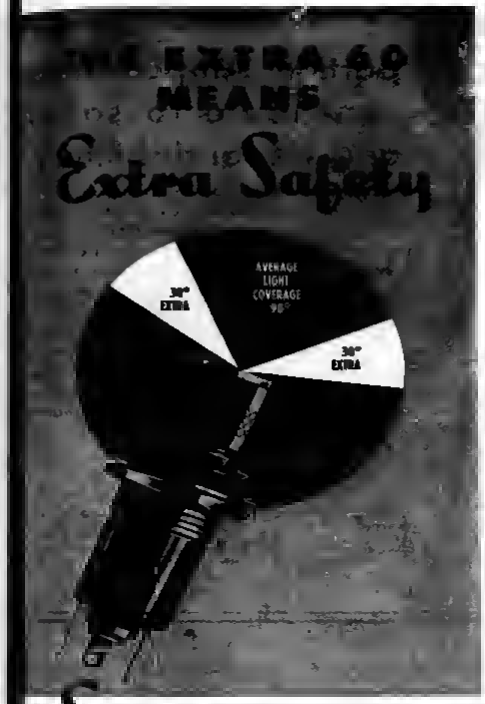

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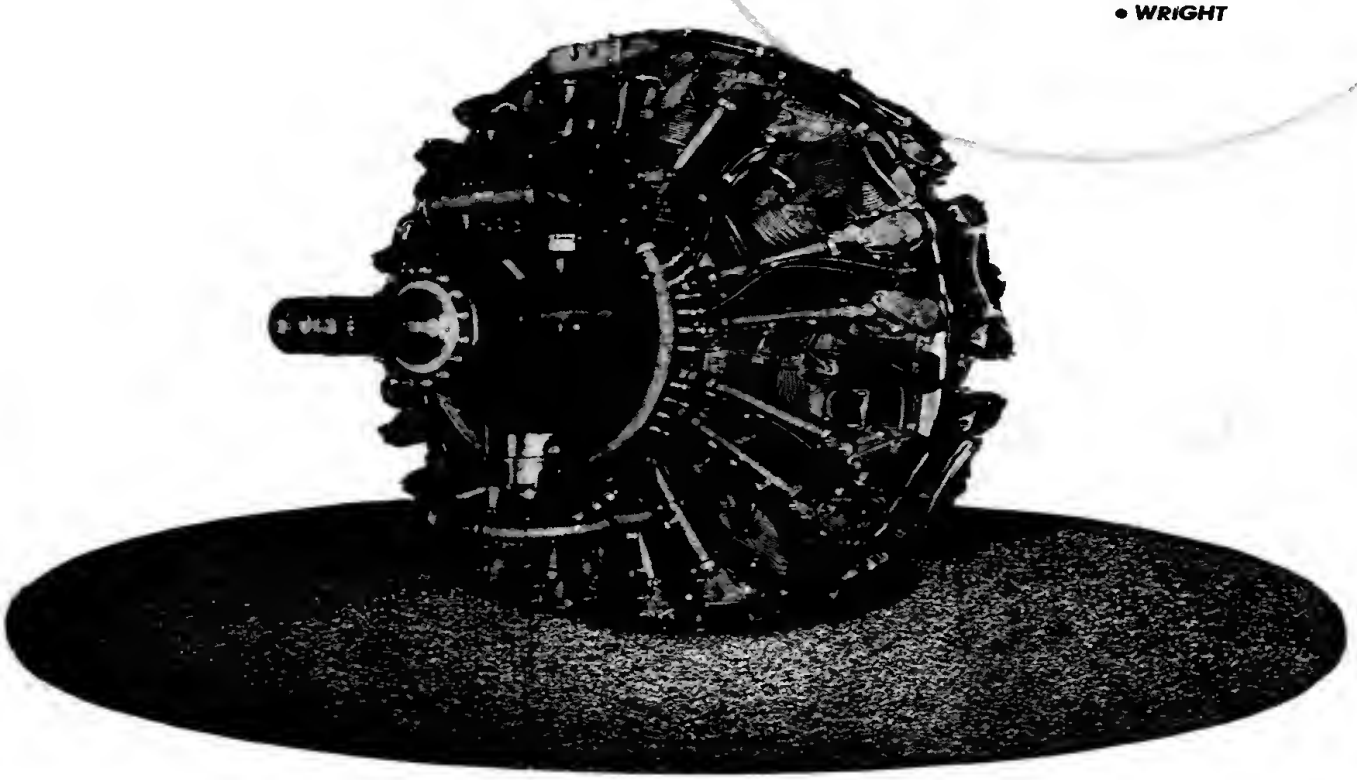

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